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نيابة العمادة المكلفة
بما بعد التدرج و البحث
العلمي و العلاقات
الخارجية

BIOETHICS' COURSE HANDOUT

Carried out by:

DR.AOUADI NAWAL .... MCB

This handout is intended for students enrolled in Master (M2) Specialty IN MOLECULAR AND CELLULAR BIOLOGY

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M'HAMED BOUGARA UNIVERSITY –BOUMERDÈS

جامعة امحمد بوقرة –بومرداس

SCIENCES FACULTY

BIOLOGY DEPARTEMENT

BIOETHICS

COURSE HANDOUT

2ND YEAR MASTER STUDENTS IN MOLECULAR AND CELLULAR BIOLOGY

Dr. Nawal AOUADI

Preface

This course aims to introduce the fundamental principles of bioethics, emphasizing its relevance in contemporary scientific research. By examining the ethical, environmental, and societal impacts of advancements in molecular biology, biotechnology, and genetic engineering, students will explore how scientific progress intersects with humanity’s responsibilities toward living organisms, ecosystems, and future generations.

Designed as a discovery unit for second-year Master’s students (M2) in Molecular and Cellular Biology , upon successful completion, students will earn 2 ECTS credits , and the course carries a coefficient of 2 within the curriculum. It is part of the broader domain of Life Sciences and Health , and is also open to students from related disciplines seeking to understand the ethical dimensions of modern biology.

The course combines theoretical foundations with interactive tutorial sessions , during which students will engage in critical discussions and presentations on pressing bioethical themes such as:

- Cloning and its societal implications
- Euthanasia and end-of-life decisions
- Animal experimentation: ethics versus scientific progress
- Organ transplants: allocation and consent
- Gamete donations and reproductive rights
- Stem cell research and its controversies
- Abortion: medical, legal, and moral perspectives
- Gene therapy and its boundaries
- Surrogacy and commodification debates
- Cryonics: science fiction or ethical frontier?
- Genetic enhancement, cosmetic surgery, and body modification
- Gender transformation and autonomy in bioethics
- Eugenics
- Digital Therapeutics and Mental Health Apps
- Public Health Surveillance in the Digital Age
- Medical Tourism and Global Health Inequity
- Artificial Wombs and Ectogenesis

- Biobanking and the Use of Human Biological Samples
- Crisis Standards of Care During Disasters
- Synthetic Biology and the Creation of Artificial Life
- De-Extinction and the Ethics of Resurrecting Lost Species

These sessions are designed to foster analytical thinking and ethical reasoning, preparing students to navigate complex moral questions in their future careers while aligning scientific innovation with societal values, sustainability, and global health standards.

Knowledge Prerequisites

The course requires a foundational understanding of molecular biology, genetic engineering, and biomedical sciences to effectively engage with the ethical debates and case studies presented:

1. Fundamental Concepts in Molecular Biology :Understanding of DNA structure, gene function, replication/transcription mechanisms, and basic genetics (mutations, gene expression, regulation).
2. Basics of Genetic Engineering :Familiarity with genetic modification techniques (CRISPR, transgenesis, cloning) and their applications/limitations in biotechnology.
3. Foundations of Biomedical Sciences :Awareness of ethical principles in medical research (informed consent, patient safety), inherited diseases.

Course Objectives : By the end of this course the student will be able to :

- List ethical principles of the bioethics and researcher codes of conduct.
- Describe the role of ethics committees in research oversight.
- Compare ethical challenges in human, animal, and environmental research.
- Apply ethical frameworks to real-world cases (e.g., clinical trials, genetic modification).
- Adapt guidelines like the Helsinki Declaration to modern research scenarios.
- Analyze controversies in biotechnologies (e.g., designer babies, GMOs).
- Debate the balance between scientific progress and ethical boundaries.
- Propose policies for regulating emerging biotechnologies (e.g., CRISPR in public health).

- Cultivate a reflective practice of integrating bioethical principles into scientific research and experimentation, prompting self-directed inquiry into the moral implications of methodologies, objectives, and outcomes.

Author's information :

- **Author** : Dr. Nawal AOUADI
- **Email:** n.aouadi@univ-boumerdes.dz
- **Affiliation** :Laboratoire de Bioinformatique et Microbiologie appliquée et Biomolécules (BMAB)-faculty of Sciences- University of M'Hamed Bougara Boumerdès-Algeria.

Course syllabus

Introduction

In a world in which doctors can cure genetic disorders before birth; artificial intelligence determines cause and prevention of diseases; cloning enables bringing back extinct species; this sounds more like science fiction, but it is coming true thanks to the advancements in biotechnology. With great power comes great responsibility, and this is where bioethics comes into play.

Bioethics is the study of all sorts of ethical issues that arise from the application of biology, medicine, and technology. The questions posed are troubling: Should we edit human DNA? Is it permissible to experiment on animals? How much can we interfere with the mechanisms of death? The essence of bioethics is to assure that the progress of science and that of our values as a society will support each other.

Bioethics has three key origins, but Van Rensselaer Potter's contribution is the most widely recognized today. Fritz Jahr, a German philosopher, first introduced the term "bioethics" in 1927, focusing on ethical relationships between humans, animals, and plants, though his work did not gain widespread attention at the time (Baños & Guardiola, 2023). In 1971, Shriver and Hellegers in Washington played a crucial role in establishing the Kennedy Institute of Ethics at Georgetown University, which concentrated on the ethical challenges arising from new medical technologies and their impact on society (Lopes, 2014) .

However, it was the American biochemist Dr. Van Rensselaer Potter, in 1970, who popularized bioethics as a broader concept in his book *Bioethics: Bridge to the Future*. Potter envisioned a field that would systematically address ethical considerations in the biological sciences and healthcare as scientific advancements began to significantly impact these domains. He emphasized the necessity for an interdisciplinary framework to confront the moral dilemmas and ethical questions that emerge in the wake of such progress.

Thus, while *Bioethics: Bridge to the Future* (1971) is often cited as the seminal work of Potter that introduced bioethics to a wider audience, it was preceded by his 1970 article ("*Bioethics, the Science of Survival"*, published in the journal *Perspectives in Biology and Medicine* (Potter, 1970).

In his article, Potter argued that traditional ethical frameworks were insufficient to deal with the complex challenges posed by rapid advancements in biology, medicine, and technology, as well as growing environmental concerns. His early contributions helped establish bioethics as a distinct field of study, bridging science, ethics, and human survival.

Photographs of the founders of bioethics *(key figures in the origins of the discipline): Fritz Jahr, Shriver and André Hellegers, and Van Rensselaer Potter by order.*

Chapter I: Foundations of Bioethics

In this chapter, students will explore the foundational concepts of bioethics, including its historical roots and the ethical principles that guide scientific and medical practices. They will examine how key events, such as landmark legal cases and the development of ethical codes, shaped modern standards for research involving humans and animals. The chapter also introduces core values like respect for autonomy, fairness, and responsibility, while addressing the balance between innovation and ethical boundaries

I.1 Origins of Bioethics

I.1.1 Definition of bioethics

The word ***«bioethics"*** consists of two parts derived from Greek:

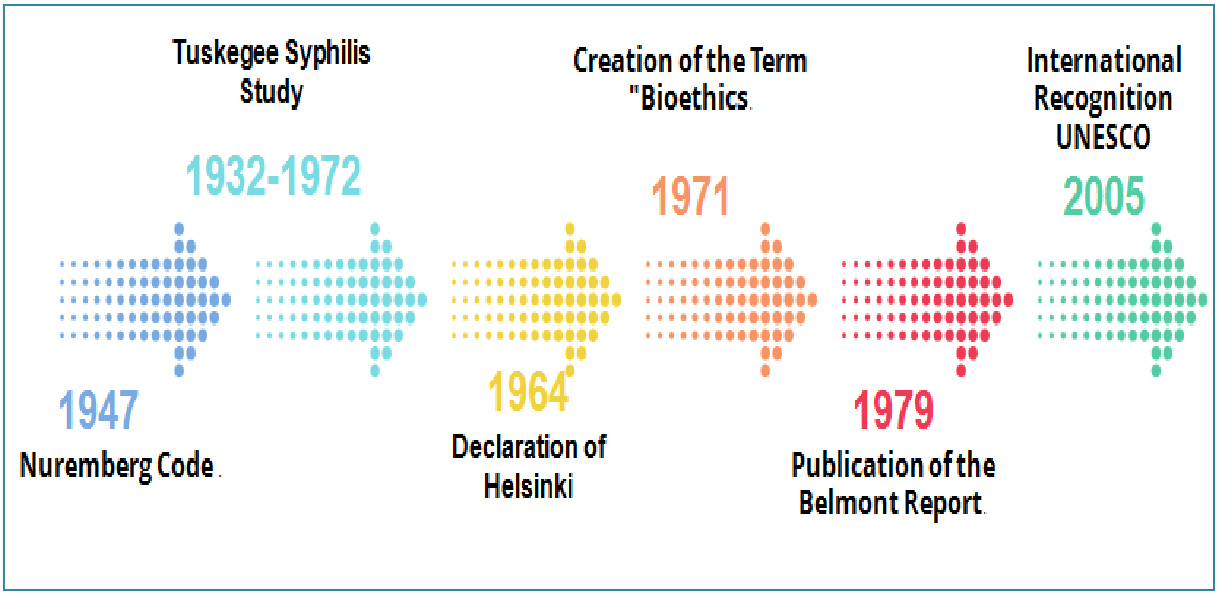
- ✓ ***Bios*** meaning life and the adjective,
- ✓ ***Ethicos*** meaning good or bad, right or wrong.

Ethics is the philosophy behind moral or the theoretical basis for moral (moral derived from the Latin word *moris* meaning manners). Based on this, bioethics should deal with ethical problems of life and also of death since death is a function of life.

One of the first formal definitions of bioethics was provided by philosopher Samuel Gorovitz in a 1977 article published in *The Hastings Center Report.* In the article, titled "Bioethics and Social Responsibility," Gorovitz describes bioethics as a philosophical analysis of the practical aspects of decision-making in health-related situations and in fields related to the biological sciences (Reports from a seminar Dr.Helland,, 2001).

I.1.2 The historical development of bioethics

The field of bioethics has evolved in response to significant historical events and ethical dilemmas in medicine and biological research. The Hippocratic Oath as one of the oldest and most famous oaths includes bioethical principles of respecting confidentiality, beneficence and non-maleficence. Over the years, religion played an important role in establishing ethical principles. Muslim, Jewish and Christian scholars began writing on ethical issues.



Key milestones of bioethics

Here are some key milestones in shaping bioethics throughout the history:

a. Nuremberg Code (1947): Established post-World War II as a response to the unethical experiments conducted by Nazi physicians, this code laid the groundwork for ethical research involving human subjects, emphasizing informed consent and voluntary participation.

The Incidents leading to the Nuremberg Code: During the war, Nazi doctors performed grotesque and often lethal experiments on prisoners without their consent, causing immense suffering and death. Some examples of these unethical experiments include (Nuremberg - Document Search Results, n.d.):

- Freezing experiments: Subjects were submerged in icy water to study hypothermia and methods of rewarming.
- High-altitude experiments: Prisoners were placed in low-pressure chambers to simulate high-altitude conditions, often leading to excruciating deaths.
- Sulfonamide and bone grafting experiments: Infections were deliberately induced in prisoners to test treatments, and limbs were amputated or subjected to experimental surgeries.
- Mustard gas experiments: Victims were exposed to toxic chemicals to study their effects on human health.
- Sterilization experiments: Researchers sought ways to forcibly sterilize individuals, often using radiation or other harmful methods.

The Nuremberg Tribunal prosecuted war criminals, exposing horrific experiments conducted by 23 individuals, including 20 doctors, for crimes against humanity. Of them, 16 were found guilty, with seven sentenced to death. In August 1947, the court issued the Nuremberg Code, a landmark document establishing ethical guidelines for human experimentation (Lopes, 2014).

The Nuremberg Code established key ethical principles for human experimentation, emphasizing the absolute necessity of voluntary consent from participants (Nunes, 2014). Experiments must aim to provide benefits to society that justify any risks involved, while also avoiding unnecessary harm and ensuring that risks do not outweigh potential humanitarian benefits. Proper preparation and protection measures must be in place to safeguard subjects, and experiments should cease if the participant becomes physically or mentally unable to endure.

b. Tuskegee Syphilis Study (1932-1972): The Tuskegee Syphilis Study, conducted by the U.S. Public Health Service (USPHS), was an unethical research project that withheld treatment from African American men (from Macon County, Alabama) with syphilis over a 40-year period, while misleading them into believing they were receiving effective care. The USPHS partnered with Tuskegee University, a historically Black college, to recruit participants from rural communities.

Of the 600 men enrolled, 399 had syphilis, and 201 served as control subjects without the disease. All participants were told they were being treated for "bad blood," a local term for various ailments, but were never informed of their true diagnosis or that they were part of a study. Instead, government doctors deliberately withheld proper treatment, such as penicillin, offering only placebos like vitamin tonics and aspirin, which did nothing to address their syphilis (Tobin, 2022).

The Tuskegee Syphilis Study came to public attention in 1972 when journalist Jean Heller of the *Associated Press* broke the story. Her reporting led to widespread outrage and condemnation of the USPHS. The study was immediately shut down, and a class-action lawsuit was filed on behalf of the victims and their families. In 1974, the U.S. government settled the lawsuit, agreeing to pay compensation and provide lifetime medical benefits to the survivors and their families.

Later in 2010, it has also been revealed that the same research group had deliberately infected hundreds of Guatemalans with syphilis and gonorrhea in the 1940s, with the goal of developing better methods for preventing these infections (Tobin, 2022).

c. Declaration of Helsinki (1964): The World Medical Association has developed the Declaration of Helsinki as a statement of ethical principles to provide guidance to physicians and other participants in medical research involving human subjects with several revisions reflecting evolving ethical standard (Human & Fluss, 2000).

d. Founding of the Hastings Center (1969): The Hastings Center, founded in 1969 by Dana Callow, Jr, with the help of Daniel Callahan and Willard Gaylin , is widely regarded as the world's first dedicated bioethics research institute. Its establishment marked a pivotal moment in the development of bioethics as a formal field of study. The center was created to address the growing ethical challenges posed by rapid advancements in medicine, biology, and technology (Callahan, 1999).

e. Creation of the Term "Bioethics" (1971): Dr. Potter's introduction of the term marked the formal recognition of an interdisciplinary field focused on ethical issues arising in biology and medicine (Potter, 1970).

f. Belmont Report (1979): Driven by a series of ethical scandals in research, such as the Tuskegee Syphilis Study.the U.S. Department of Health issued this report to articulate ethical principles for research involving human subjects, to emphasize the respect for persons, beneficence, and justice and their specifc applications (Informed Consent, Assessment of Risks and Benefts, and Selection of Subjects) (Nagai et al., 2022)

g. Advancements in Medical Technology: The rapid technological progress in medicine during the late 20th century, including organ transplantation and genetic engineering, raised numerous ethical inquiries, furthering the field of bioethics.

h. Legal Cases and Public Awareness: High-profile cases, such as Karen Ann Quinlan's and Baby Doe's, highlighted bioethical issues such as end-of-life decisions and resource allocation, raising public awareness and debate.

Karen Ann Quinlan's case

In 1975, Karen Quinlan (21-year-old woman) had a “respiratory arrest.” (a persistent vegetative state (PVS) after suffering irreversible brain damage due to a drug overdose and lack of oxygen.) She was resuscitated and left in what was initially described in the records as a coma. Later it was determined she was vegetative. Karen’s parents asked that her mechanical ventilator be removed so that she might die, and the doctors refused.

The case was eventually adjudicated in the New Jersey Supreme Court. In 1976, this court supported the parents in their request to allow removal of the ventilator, based on the right to privacy. The court found that families are adequate surrogates for incapacitated patients who did not and could not make their wishes known (Fine, 2005).

Ethical Issues Raised:

- Patient Autonomy: The case highlighted the importance of respecting a patient's right to refuse or discontinue treatment, even if they cannot express their wishes directly.
- End-of-Life Decisions: It brought attention to the ethical and legal complexities of withdrawing life-sustaining treatments.
- Role of Families and Courts: The case underscored the role of families and judicial oversight in making decisions for incapacitated patients.

Similar to the Karen Ann Quinlan case, other landmark cases, such as Nancy Cruzan (1983-1990) and Terri Schiavo (1990-2005), involved patients in a persistent vegetative state and raised critical questions about end-of-life decisions and patient autonomy. In the Cruzan case, her parents fought to remove her feeding tube, ultimately leading to a groundbreaking Supreme Court ruling that affirmed the right to refuse life-sustaining treatment while setting a precedent for requiring "clear and convincing evidence" of the patient's wishes.

The Schiavo case ignited a highly publicized legal battle between her husband, who sought to discontinue life support, and her parents, who opposed it. Like Quinlan, both cases necessitated judicial intervention to resolve deeply divisive family disputes and underscored the crucial need for advance directives to guide ethical decision-making in complex medical situations (Fine, 2005).

Baby Doe cases

The "Baby Doe" cases refer to a series of high-profile incidents in the 1980s where infants born with severe congenital disabilities were denied life-saving medical interventions by their parents or doctors. One notable case involved an infant, Baby Doe, who was born with trisomy 21 (Down syndrome) as well as esophageal atresia and tracheoesophageal fistula conditions that prevented him from eating safely but were correctable with a straightforward surgical procedure. However, after being told by the medical team that the baby would likely have severe disabilities and an unacceptable quality of life due to his trisomy 21, the parents declined the life-saving surgery, and the infant died in the hospital nursery six days later. (Kett, 2020).

This decision sparked substantial public attention and national debate, leading to the creation of the federal Baby Doe Regulations by the U.S. Department of Health and Human Services (HHS). These regulations required hospitals to post hotline numbers in public spaces for reporting concerns and authorized Baby Doe Squads to investigate complaints of medical care being withheld from newborns with disabilities.

Key Ethical Concerns:

- Parental Rights vs. Child Protection: These cases raised questions about whether parents have the right to refuse life-saving treatment for their children based on perceived quality of life.
- Disability Rights: The Baby Doe cases highlighted concerns about discrimination against individuals with disabilities.
- Medical Decision-Making: They prompted discussions about the role of physicians, parents, and government agencies in making life-and-death decisions for newborns.

k. International Recognition: Organizations like United Nations Educational, Scientific, and Cultural Organization (UNESCO) have recognized the importance of bioethics, notably through the adoption of the Universal Declaration on Bioethics and Human Rights in 19th October 2005 ,this landmark document addressing the ethical challenges posed by advancements in science and technology was the culmination of nearly 2 years of deliberations and negotiations (Langlois, 2008, 2011).

The preamble emphasizes the pressing need for the international community to establish universal principles that can guide humanity in navigating the growing dilemmas and controversies arising from scientific progress.'' *It is necessary and timely for the international community to state universal principles that will provide a foundation for humanity's response to the ever- increasing dilemmas and controversies that science and technology present for humankind and the environment''* (UNESCO, 2005).

The UNESCO declaration is considered to be of added value because it is the first intergovernmental instrument on bioethics, and it could be used in designing national policy on biomedical research ethics, particularly in developing countries (Langlois, 2008).

Based on UNESCO's official website, the organization took the lead in creating the Universal Declaration on Bioethics and Human Rights due to its unique role in setting global ethical standards. UNESCO's previous work, such as the 1997 Declaration on the Human Genome and the 2003 Declaration on Human Genetic Data, showcased its ability to address complex ethical issues arising from scientific advancements. As the only UN body specializing in social and human sciences, UNESCO is well-equipped to consider the cultural, philosophical, and religious dimensions of these challenges, making it the ideal authority for this initiative.(*Universal Declaration on Bioethics and Human Rights | UNESCO*, 2005).

Bioethics then settled as a new global field, although of multi- and transdisciplinary nature. Global bioethics means not only the adoption of a unique universal ethics but also the inclusion of all matters that relate to the life sciences. In a broad sense, to this concept is also associated an essential dimension of the practice of medicine and biomedicine that is a set of duties inherent in any healthcare profession (Nunes, 2014).

These historical developments have collectively shaped bioethics, resulting in the establishment of ethical guidelines and ongoing discussions regarding moral issues in healthcare and research. Today, bioethics continues to adapt and respond to new challenges in medical practice and biotechnology.

I.2 Domains of Bioethics

Bioethics systematically investigates ethical concerns, moral principles, and values related to:

1. Life Sciences

Bioethics examines the ethical implications of advancements in genetics, biotechnology, and reproductive technologies. This includes debates on genetic manipulation, cloning, gene editing (e.g., CRISPR), and the potential societal impacts of such innovations. So Genome editing technologies have revolutionized genetic science, with CRISPR-Cas9 standing out due to its simplicity, precision, and affordability. This technology has been rapidly adopted in human, animal, and environmental applications but also raises significant ethical questions and concerns. A primary concern lies in the use of CRISPR-Cas9 for germline genome editing, which involves altering human embryos or reproductive cells.

This practice poses bioethical challenges, such as the risk of unintended genetic changes, the complexities of obtaining informed consent, and the potential for eugenics (the breeding of the human species). However, it is equally important to consider the broader bioethical implications of CRISPR-Cas9 in areas like agriculture, livestock, and environmental management, where unintended consequences may also arise (Ayanoğlu et *al*., 2020).

2. Clinical Medicine

In real-world medical settings, bioethics deals with important matters such as getting patients' informed agreement, respecting their right to make their own choices, keeping their information private, managing end-of-life care, and ensuring fair access to healthcare. These issues make sure that healthcare decisions honor personal rights while also fostering justice and beneficence. The landmark case of Karen Ann Quinlan exemplifies bioethical dilemmas surrounding end-of-life decisions (Fine, 2005).

3. Research Ethics

Research ethics is all about making sure that studies involving people, animals, and the environment are conducted ethically. It sets up rules for review boards, informed consent, and how data should be collected. The Belmont Report from 1979 is still a key resource, highlighting important principles like respect for persons, beneficence, and justice (Nagai et al., 2022).

4. Public Health

Bioethics is essential in guiding public health decisions, carefully weighing personal freedoms against the good of the community. Matters like vaccine requirements, handling outbreaks, and tackling health inequalities need thoughtful ethical consideration. For instance, during the COVID-19 crisis, bioethicists discussed how to fairly distribute vaccines.

The article "Fair Allocation of Scarce Medical Resources in the Time of Covid-19" by Emanuel *et al.*, (2020), published in the New England Journal of Medicine, discusses six essential guidelines for ethically sharing limited medical resources during the COVID-19 crisis:

- ✓ **Save the Most Lives and Improve Health Outcomes:** Focus on treatments and interventions that are most likely to save lives or significantly improve health conditions. This means prioritizing interventions with the highest chances of success.
- ✓ **Prioritize frontline Workers:** Make sure healthcare professionals and other key workers get priority access to resources like personal protective equipment (PPE) and vaccines to ensure they can continue providing care.
- ✓ **Avoid a First-Come, First-Served Approach:** Don't rely solely on a first-come, first-served system for distributing resources. Take into account factors like clinical need, potential benefits, and fairness in distribution.
- ✓ **Be Open and transparent About Allocation Policies:** Clearly explain the criteria and methods used for distributing scarce resources to build public trust and ensure accountability.
- ✓ **Acknowledge Participation in Research:** Give preference to those taking part in clinical trials for treatments or vaccines, recognizing their role in advancing medical knowledge and helping society.
- ✓ **Support Vulnerable Groups and Reduce Inequities**: Ensure that people, who are particularly vulnerable, such as those with economic disadvantages or pre-existing conditions, are not unfairly affected by resource shortages. Make allocation decisions that promote fairness and reduce disparities.

5. Environmental Ethics

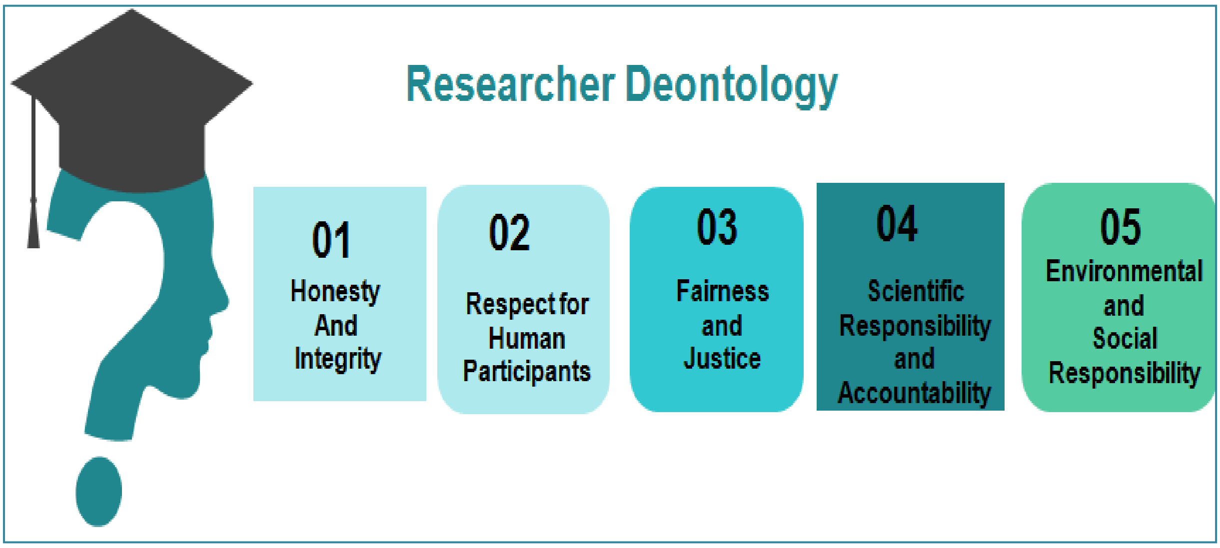
Although often not viewed as a core area of bioethics, environmental ethics have developed as we face increasing global challenges. While the "land ethic" emphasizes local conservation and the careful use of natural resources, it isn't enough to tackle today's worldwide environmental problems, like ozone layer damage, loss of biodiversity, and climate change. These concerns, which gained significant attention in the mid-1980s, require a wider viewpoint. What we need is an earth ethic that encourages global responsibility and sustainability, making sure our actions protects the whole planet instead of just specific areas. This new approach highlights our collective duty to take care of the entire Earth and its ecosystems. This field involves evaluating how our actions affect ecosystems and promoting the idea of sustainable growth. Philosopher J. Baird Callicott has played a major role in this area by connecting environmental issues with ethical ideas (Callicott, 2021).

I.3 Elements of a Researcher's Deontology

The word deontology derives from the Greek words for duty (*deon*) and science (or study) of (*logos*). In contemporary moral philosophy, deontology is one of those kinds of normative theories regarding which choices are morally required, forbidden, or permitted (*Deontological Ethics (Stanford Encyclopedia of Philosophy)*, n.d.).

Researcher deontology is about the ethical responsibilities that direct how researchers should behave in scientific, medical, or academic studies. It focuses on sticking to moral values, like being truthful, having strong ethical standards, showing respect to participants, and being accountable to society, animals, and the environment. These responsibilities ensure that research is carried out with fairness, openness, and accountability, fostering trust between researchers and the public.

1.3.1 Key Aspects of Researcher Deontology



Some aspects of reseaarcher's deontology

Honesty and Integrity

Researchers must avoid fabrication, falsification, or plagiarism, ensuring that their work is truthful and reliable. The Baltimore Affair, as covered in David B. Resnik's The Ethics of Science: An Introduction (2005), is a pivotal case underscoring the vital role of honesty in scientific research. It revolves around Dr. Thereza Imanishi-Kari, a scientist at MIT, and Nobel Prize winner Dr. David Baltimore, who together published a paper in 1986. The paper claimed that experiments showed that the insertion of a foreign gene into a mouse can induce the mouse’s genes to produce antibodies mimicking those of the foreign gene. If this claim were true, it would suggest that one could control the immune system by using foreign genes to make it produce antibodies .Margot O'Toole, a postdoctoral researcher working with Imanishi-Kari, claimed that the data in the paper had been made up or altered. This accusation sparked a widely-publicized investigation into misconduct in science (Resnik, 2005).

Theresa‘s claims remain scientifically unverified and highly debated. While modern genetic engineering techniques, such as CRISPR-Cas9, allow for precise manipulation of genes and the study of immune responses, no subsequent studies have replicated or validated the specific findings reported in the original paper.

Resnik uses this case to illustrate how complex ethical issues can arise in science, even involving esteemed figures, and the importance of maintaining trust through rigorous adherence to ethical standards.

Respect for Human Participants

Researchers are obligated to protect the rights and welfare of human subjects through informed consent (must secure informed, voluntary consent from participants, ensuring their comprehension of the study's purpose and risks), confidentiality, and minimizing harm (beneficence).The Belmont Report: Ethical Principles and Guidelines for the Protection of Human Subjects of Research" (U.S. Department of Health and Human Services, 1979). This document outlines the core principles of researcher deontology in human subject research.

Fairness and Justice

Researchers must ensure equitable access to research benefits and avoid exploiting vulnerable populations, particularly in global health and development contexts. The European Charter for

Researchers promotes equality and non-discrimination in research practices, ensuring that opportunities are accessible to all regardless of gender, race, or background (Emanuel et *al*., 2004 ; Vergès, 2008).

Scientific Responsibility and Accountability

Researchers are encouraged to act responsibly by considering the societal impact of their work. This includes minimizing potential harm and promoting the welfare of both human and animal subjects. In studies involving animals, researchers must adhere to humane treatment and minimize suffering, aligning with ethical guidelines for animal care.

The Guide for the Care and Use of Laboratory Animals (referred to as *the Guide*), published by the Institute for Laboratory Animal Research (ILAR) in 2011 through the National Academies Press, serves a dual purpose. First, it aims to support institutions in providing care and utilizing animals in manners that are considered scientifically sound, technically feasible, and humane. Additionally, the Guide seeks to aid researchers in meeting their ethical obligations by designing and conducting animal experiments according to the highest standards of scientific rigor, compassion, and ethical integrity. This resource reflects a commitment to ensuring that the use of animals in research is not only justified but also carried out with respect and accountability ("Guid. Care Use Lab. Anim.," 2011)

Environmental and Social Responsibility

Researchers have a critical responsibility to ensure their work minimizes harm to ecosystems and preserves natural resources for future generations. The European Charter for Researchers, while not always explicitly stating this obligation, implicitly calls upon researchers to reflect on the environmental and societal consequences of their activities.

By promoting sustainable practices, the charter aligns with a broader deontological commitment to protect both the planet and society. This responsibility extends beyond immediate research outcomes, urging scientists to consider the long-term impacts of their work on global ecosystems and social well-being. Ultimately, this ethical duty reflects a dedication to safeguarding the interests of future generations, ensuring that scientific progress is harmonized with environmental care and social responsibility (Vergès, 2008).

1.3.2 Key principles in bioethics

Bioethics provides a broader framework of principles to guide ethical decision-making in medicine, science, and health care, among these are autonomy, non-maleficence, confidentiality, dignity, honesty, justice and beneficence.

Key core principles of bioethics

the following are the foundational principles (Summers & Morrison, 2009) :

Autonomy: Autonomy as a concept means that the person is self-ruling. The term auto is from Greek and means “self.” The rest of the term comes from the Greek nomos, which means “rule” or “law.

Respecting individuals' rights to be fully informed about their healthcare options and obtaining their consent before any medical intervention is a cornerstone of ethical healthcare practice. However, ensuring patient autonomy in a clinical setting can be complex, as it requires meeting two key conditions: competence to make informed decisions and freedom from coercion. While patients must demonstrate the ability to understand and weigh their options, they must also be free from external pressures that could compromise their choice. These considerations underscore the essence of autonomy;the right to make choices based on personal values and preferences, emphasizing the importance of empowering patients in their healthcare journey (Campbell, 2017).

Beneficence and Non-Malfeasance: The principle of beneficence involves a dedication to doing what's best for others, actively supporting their well-being with responsible and kind care. It surpasses just avoiding harm by reflecting a greater level of selflessness than merely not causing harm. Beneficence is seen as an overarching ethical guideline that leads to specific rules like "Do no harm," "Weigh benefits against risks," and "Increase potential benefits while reducing possible harms" (Beauchamp, 2008).

Justice: Justice refers to the ethical obligation to treat each person in accordance with what is morally right and proper, to give each person what is due to him or her. In the ethics of research involving human subjects the principle refers primarily to distributive justice, which requires the equitable distribution of both the burdens and the benefits of participation in research. Differences in distribution of burdens and benefits are justifiable only if they are based on morally relevant distinctions between persons; one such distinction is vulnerability.

Dignity: Treating individuals with respect, recognizing their inherent worth, and honoring their rights regardless of health status.

Veracity: Upholding honesty and transparency in medical communication, ensuring patients receive accurate information about their care.

I.4 The Declaration of Helsinki

The Declaration of Helsinki, established by the World Medical Association **(WMA**) which is an international organization representing physicians. It was founded on 17 September 1947, when physicians from 27 different countries met at the First General Assembly of the WMA in Paris. The organization was created to ensure the independence of physicians and to work for the highest possible standards of ethical behavior and care by physicians, at all times (T*he World Medical Association*, n.d.).

The Declaration of Helsinki is a cornerstone of ethical principles guiding medical research involving human subjects, including studies on identifiable human material and data. Its origins trace back to the aftermath of World War II (1939–1945) , when the “Doctors’ Trials” in Nuremberg, Germany (1946) exposed the horrific experiments conducted by Nazi physicians on concentration camp prisoners without their consent(Williams, 2008).

These atrocities led to the creation of the Nuremberg Code (1947), which established ten principles for ethical research, emphasizing voluntary consent , scientific justification, and participant safety. Building on this foundation, the World Medical Association (WMA) adopted the Declaration of Geneva (1948), a modernized Hippocratic Oath reaffirming the humanitarian goals of medicine. To address the specific challenges of clinical research, the WMA introduced the Declaration of Helsinki in 1964 during its 18th General Assembly in Helsinki, Finland.

This declaration combined the ethical principles of the Nuremberg Code and the Declaration of Geneva, aiming to maintain high global ethical standards in medical research. Since its inception, the Declaration of Helsinki has been revised nine times (table1) by the WMA’s General Assembly, ensuring its relevance in response to evolving scientific and societal challenges.

Table 1. Timelines of WMA meetings and revisions of the Declaration of Helsinki

Adopted by the 18th WMA General Assembly, Helsinki, Finland, June 1964
and amended by the:
29th WMA General Assembly, Tokyo, Japan, October 1975
35th WMA General Assembly, Venice, Italy, October 1983
41st WMA General Assembly, Hong Kong, September 1989
48th WMA General Assembly, Somerset West, Republic of South Africa, October 1996
52nd WMA General Assembly, Edinburgh, Scotland, October 2000
53rd WMA General Assembly, Washington DC, USA, October 2002 (Note of Clarification added)
55th WMA General Assembly, Tokyo, Japan, October 2004 (Note of Clarification added)
59th WMA General Assembly, Seoul, Republic of Korea, October 2008
64th WMA General Assembly, Fortaleza, Brazil, October 2013
and by the 75th WMA General Assembly, Helsinki, Finland, October 2024

For instance, the seventh revision has made four substantial changes on the existing Declaration, which include dealing with the compensation of the trial-related injuries, approval of use of placebos in the clinical trials, protection of vulnerable groups and the post-trial provisions. The implications of these amendments in the clinical research are highlighted (Shrestha & Dunn, 2020).

Based on Bibbins-Domingo et *al.*, (2025),bellow are the latest updates of Declaration of Helsinki' revision in 2024:

1. Responsible Inclusion in Research

- The revision emphasizes responsible inclusion of underrepresented and marginalized groups in research, balancing the need for protection with the risks of exclusion.
- It seeks to address health disparities caused by overprotective policies that historically excluded vulnerable populations from clinical trials.
- Both researchers and research ethics committees share responsibility for implementing these principles.

2. Community Engagement and Global Responsibility

- The Declaration now stresses the importance of community engagement in research design and implementation.
- It highlights a global responsibility to avoid waste in research and considers the ecological impact of research activities, aligning with growing concerns about environmental sustainability.

3. Shift from "Subjects" to "Participants"

- The terminology has been updated to refer to research volunteers as "participants" rather than "subjects," reflecting their role as partners in research .
- This change underscores the importance of involving patients and communities as active collaborators in the research process.

4. Broader Scope for Low- and Middle-Income Countries (LMICs)

- The revision adopts more inclusive language to ensure its applicability to LMICs, particularly in the Americas.

- Lessons learned from the COVID-19 pandemic have informed changes aimed at improving research practices in resource-limited settings, ensuring equitable access to the benefits of research.

5. Addressing Artificial Intelligence (AI) and Data Privacy

- The Declaration acknowledges the growing role of artificial intelligence (AI) in healthcare and research.
- It emphasizes the need for ethical data governance, improved AI literacy, and clarity regarding the risks and applications of AI technologies.
- Protecting participant data is a key focus, given the rapid advancements in digital health technologies and big data analytics.

6. Future-Proofing Research Ethics

- The revision moves beyond the traditional focus on individual participants to consider broader ethical challenges, such as interdisciplinary research and community-level impacts.
- Commentators note that the updated principles will require elaboration and specification to be effectively applied by researchers and ethics committees.

7. Ethical Oversight for All Clinical Trials

- A companion article in the JAMA collection discusses the need to make ethical oversight of clinical trials more "fit for purpose."
- Current frameworks often overprotect participants in low-risk studies while under-protecting patients in clinical practice.
- Recommendations include revisiting participant consent practices ("right-sizing") to align with the risk and intent of different types of research.

8. Living Document Responsive to Contemporary Issues

- The Declaration is described as a living document that evolves to address emerging ethical challenges.
- The 2024 revision reflects a growing appreciation for:

- Global ethical challenges
- Fair and responsible inclusivity
- Community and local engagement
- The complexity of interdisciplinary research

The Declaration of Helsinki is not an official legal document and the WMA has no legal authority. Rather, the Declaration is an ethical document that remains the most influential code of ethics guiding medical research over 6 decades because of its sound and respected recommendations.

I.5 Ethics of Research on Human Beings

During the 80's, a more elaborate document was created on the subject, called: "International Guidelines for Biomedical Research with Human Beings", this document was produced by the Council for International Organizations of Medical Sciences CIOMS, in association with WHO.

The Council for International Organizations of Medical Sciences (CIOMS) is an international nongovernmental organization in official relationship with World Health Organization. It was founded under the auspices of WHO and the United Nations Educational, Scientific and Cultural and Organization (UNESCO) in 1949.

In the first version of the CIOMS Guidelines, The regulatory standards are based on the subject of the study receiving and understanding information concerning the study, followed by his/ her consent; the researcher's obligations; the protection of vulnerable groups or those with reduced autonomy such as children, people with mental or behavioral disorders, prisoners, individuals from underdeveloped communities and pregnant women; in the constitution and responsibility of ethical review committees (CIOMS, 2002).

the key updates of the 2016 CIOMS guidelines include addressing emerging technologies (genomics, big data), strengthening protections for vulnerable populations, revising informed consent processes, emphasizing post-trial access and benefit-sharing, promoting global collaboration, considering environmental/social impacts, providing guidance for public health emergencies, clarifying stakeholder roles, integrating human rights principles, and enhancing transparency and accountability (CIOMS, 2016).

I.6 Animal Experimentation ethics

With the privilege of conducting research on animals comes a profound responsibility to ensure the ethical treatment and welfare of the animals involved. In recognition of this responsibility, the 3R principles have emerged as a fundamental framework to guide researchers in conducting animal experiments ethically within research institutes.

The 3R principles, introduced by Russell and Burch in 1959, advocate for the Replacement, Reduction, and Refinement of animal use in research (*The 3Rs | NC3Rs*, n.d.) :

Replacement

For decades, animal models have been central to scientific research, including studies related to human health. However, they are often costly, time-consuming, and limited in their relevance to human biology, prompting the need for alternative approaches. Recent advances in science and technology now offer viable opportunities to replace or reduce animal use in research.

Replacement is categorized into two types: full and partial. Full replacement eliminates the use of animals entirely, utilizing methods such as human volunteers, tissues, cells, mathematical models, computer simulations, and established cell lines. Partial replacement involves the use of animals not considered capable of experiencing suffering, such as invertebrates (e.g., Drosophila and nematode worms) or immature forms of vertebrates, as well as primary cells and tissues sourced from animals euthanized solely for this purpose, without undergoing procedures that cause pain or distress. These alternatives aim to address ethical concerns while advancing scientific innovation.

Reduction

Reduction focuses on minimizing the number of animals used in research while maintaining the scientific objectives. This involves designing and analyzing studies effectively to ensure robust, reproducible results and maximizing the data obtained per animal. Techniques such as advanced imaging modalities enable longitudinal measurements in the same animal, reducing the need for multiple cohorts, while micro-sampling allows repeated blood collection from a single animal.

However, it is crucial to balance reduced animal numbers with the potential for increased suffering due to repeated procedures. Additionally, sharing data, resources, and tissues between researchers and organizations can further contribute to achieving reduction goals.

Refinement

Refinement aims to minimize pain, suffering, distress, or lasting harm to research animals while enhancing their welfare. It encompasses all aspects of animal use, including housing, husbandry, and scientific procedures. Examples include providing species-appropriate housing, using anesthesia and analgesia to reduce pain, and training animals to cooperate with procedures to minimize stress.

Refinement is not only an ethical imperative but also a scientific necessity, as evidence shows that pain and suffering can alter an animal’s behavior, physiology, and immune response, leading to variability in experimental results. By reducing such stressors, refinement improves the reliability and repeatability of studies, benefiting both animals and research outcomes.

To ensure continual animal welfare, regular monitoring and assessment are essential to gauge the well-being of the animals during the experiment.

Chapter II: Areas of Bioethics

In this chapter, students will explore the ethical dimensions of biotechnological advancements and their impact on humans, animals, and the environment. They will examine debates surrounding technologies like *in vitro* fertilization, gene editing, and surrogacy, as well as interventions such as organ transplants, neuroenhancement, and bionic prosthetics, weighing risks, benefits, and societal implications.

The chapter also delves into ethical challenges in clinical research, including stem cell studies, trials involving vulnerable populations, and the principles governing responsible experimentation. Students will analyze the moral responsibilities tied to biodiversity conservation, climate change, and sustainable resource use, alongside frameworks like the 3Rs for ethical animal research and oversight mechanisms in scientific practice.

By engaging with real-world cases and global dilemmas, learners will develop critical tools to assess how bioethics guides innovation while safeguarding human dignity, ecological balance, and social justice.

II.1 Biotechnologies Applied to Humans

Biotechnologies applied to humans encompass a wide range of scientific and medical advancements that can bring about significant benefits but also raise complex ethical and moral questions. This section explores three primary areas: human procreation, interventions on the human body, and experimentation.

II.1.1 Human Procreation

Biotechnologies have transformed human procreation in various ways, mostly by the use of assisted reproductive technology (ART):

In Vitro Fertilization (IVF)

Undoubtedly, a couple who are having difficulties in conceiving, having a child an ultimate goal, in an attempt to achieve this goal, many will avail assisted reproductive technology (ART) or natural family planning methods.

ART includes several methods to help with fertility. The main ones are:

1. IVF (In Vitro Fertilization): Eggs and sperm are combined in a lab to create embryos.
2. ICSI (Intra-cytoplasmic Sperm Injection): A single sperm is injected directly into an egg in the lab.
3. Artificial Insemination: Sperm is placed directly into a woman's reproductive system; the sperm can be from her partner or a donor.
4. GIFT (Gamete Intra-fallopian Transfer): Eggs and sperm are mixed and then placed into the fallopian tube so fertilization happens inside the body, unlike IVF and ICSI which happen in the lab.

IVF allows couples experiencing infertility to conceive, offering hope to many families. However, one of the most significant ethical concerns surrounding ART is the creation and destruction of human embryos, particularly in IVF. Many embryos are discarded or frozen indefinitely, raising questions about their moral status and whether it is ethically acceptable to treat them as disposable biological material (Aznar & Tudela, 2020).

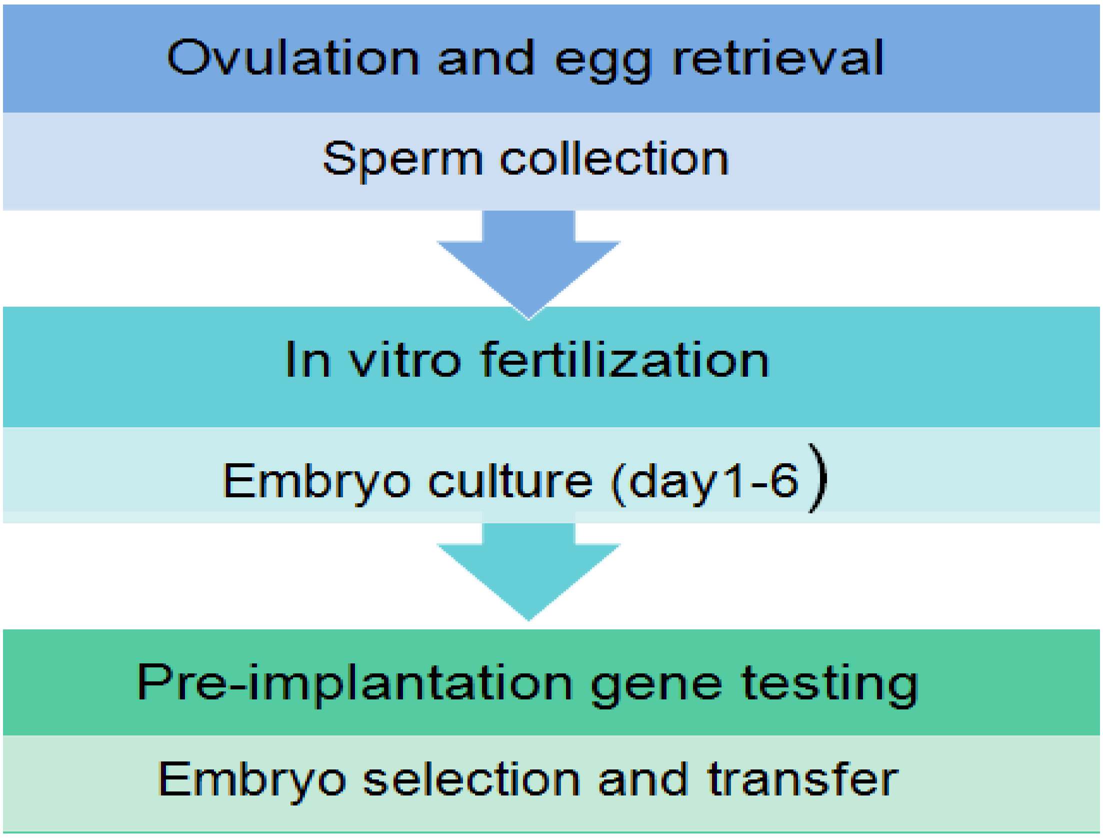
This issue becomes even more complex when considering the challenges of ensuring informed consent in ART procedures. Given the emotional and financial pressures faced by couples seeking fertility treatments, there are concerns that patients may not fully understand the risks, success rates, or long-term implications of these technologies, including the fate of unused embryos. Thus, the ethical dilemmas surrounding embryo creation and disposal are closely tied to the need for transparent and comprehensive informed consent.

Pre-implantation Genetic Diagnosis (PGD)

PGD, or pre-implantation genetic diagnosis, is a lab technique used to examine embryos for genetic or chromosomal issues before they are placed in the uterus. The main goal of PGD is to check if embryos have abnormalities or carry genes linked to diseases, especially in couples who are at high risk of passing on genetic conditions to their children.

It's also commonly used in assisted reproduction to screen for chromosomal problems; ensuring only healthy embryos are implanted. Additionally, PGD is now being used more often to help prevent diseases that might develop later in life (Mertes & Pennings, 2020).

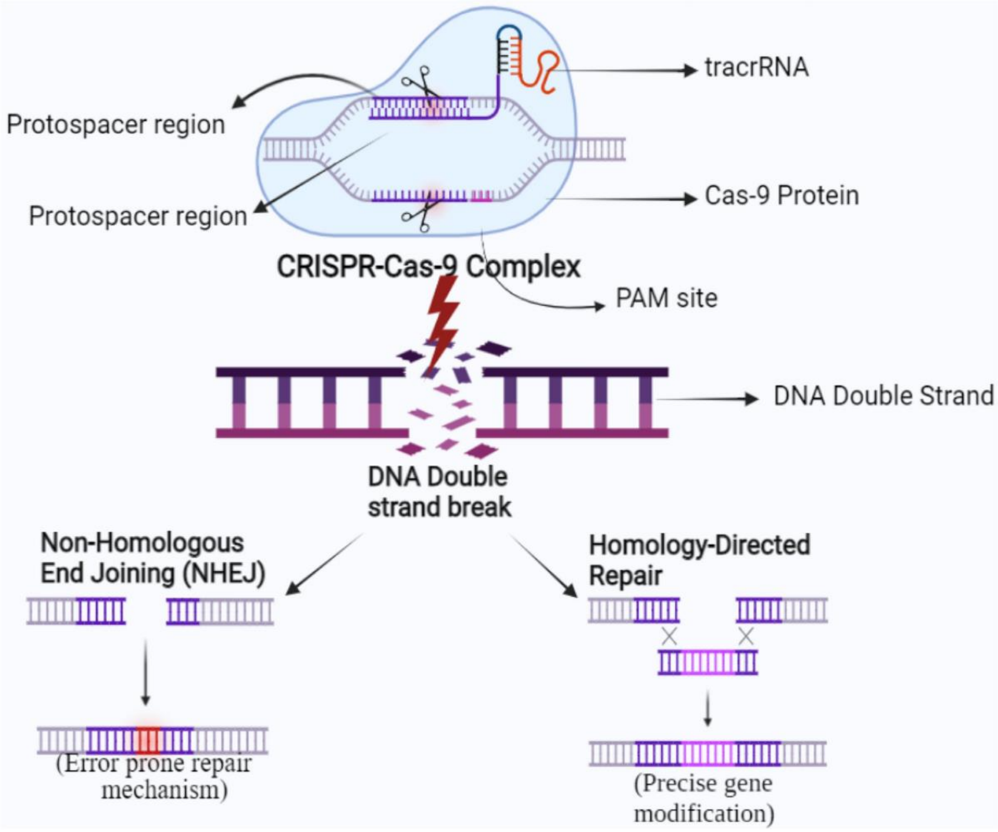
However, it raises concerns about the possibility of selecting embryos based on non-medical traits, sometimes referred to as "designer babies" .



IVF → PGD Flowchart From fertilization to embryo selection

Gene Editing

CRISPR, short for Clustered Regularly Interspaced Palindromic Repeats, is a gene-editing technology that allows researchers to correct errors in the genome. The process gives the ability to turn genes on or off in cells and organisms quickly, inexpensively, and with relative precision.



CRISPR-Cas9 Mechanism : Simple cut-edit-repair process

Technologies like CRISPR-Cas9 allow precise gene editing to prevent genetic diseases. However, they also spark ethical debates about creating "designer babies" and the potential unintended consequences of altering human genetics; bellow mentioned some ethical issues associated with the use of Pre-implantation Genetic Diagnosis (PGD) and gene editing technologies for a designer babies based on Page (2024):

- ✓ **Non-Therapeutic Use**: While PGD has mainly been used for medical reasons, its potential application in choosing cosmetic or non-medical traits raises ethical issues about treating children as products of choice rather than as individuals who deserve unconditional acceptance.
- ✓ **Eugenics and Discrimination:** The ability to select specific traits could lead to a new form of eugenics, where certain genetic features are preferred over others. This may worsen societal inequalities and encourage discrimination against those deemed "less desirable" due to their genetic attributes.

- ✓ **Parental Rights vs. Child Autonomy:** Allowing parents to choose traits for their children may infringe on the child's autonomy, as these choices are made before the child even exists. This raises questions about the rights of potential children and the ethical implications of making such significant decisions on their behalf.
- ✓ **Socioeconomic Divide:** There is concern that access to genetic enhancements could be limited to wealthier individuals, creating a genetic divide where affluent parents can have enhanced offspring while less privileged groups cannot, leading to increased social stratification and potential "genetic classes."
- ✓ **Lack of Regulation:** Currently, there is minimal oversight governing the use of PGD and gene editing, which can lead to ethical abuses and unforeseen consequences. The article argues for the need for regulatory frameworks to ensure these technologies are used responsibly and ethically.

Jiankui HE case (2018)

For many years, due to the ethical issues arising out of germ line therapy, this technology was only used on animals; however, recently scientists have tried to use it on humans as well.

One of the most important germ line therapies that have been done recently is the project done by the Chinese scientist *Jiankui HE* (the Southern University of Science and Technology in Shenzhen, China) in which he genetically altered a pair of twin girls (Lulu and Nana) who were born in November 2018 and are claimed to be the world’s first genetically edited human babies. What HE was targeting was a gene called CCR5 which is responsible for immune system functions and mutations to which could give people resistance to HIV but the problem is CCR5 has a bigger role in the body than just making people vulnerable to HIV (Gallagher, 2019).

The debate over the ethical and scientific aspects of this modification is still going on; however, most scientists believe that this mutation could shorten life expectancy the baby girls, bellow moral Implications in Dr. He's Case (Chen et *al*., 2024)**:**

- **Informed Consent**: There were serious doubts about whether the parents fully understood the risks and consequences of the gene-editing procedure, raising concerns about whether true informed consent was obtained.

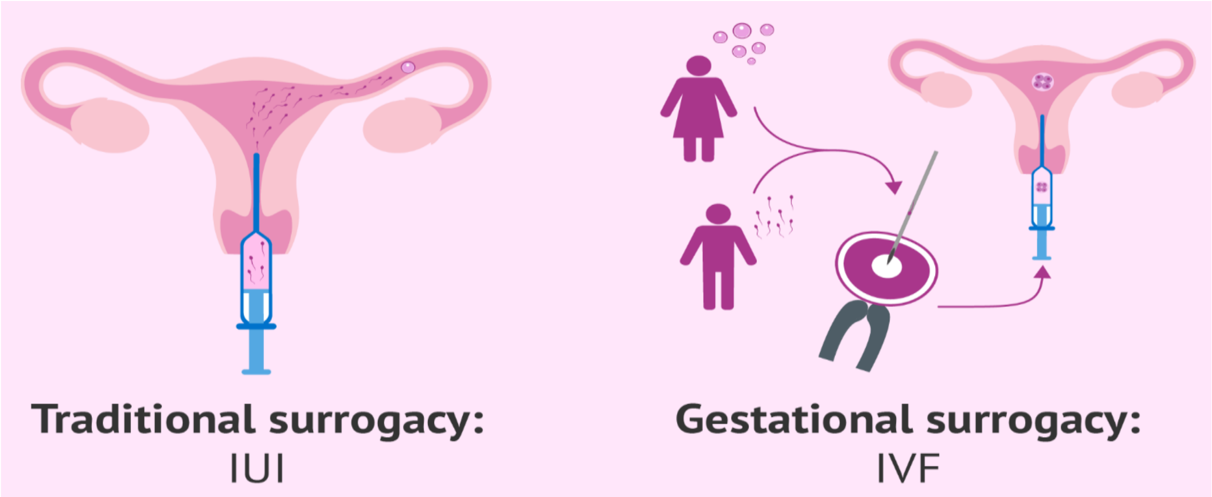
- **Safety and Efficacy**: The experiment was conducted without enough evidence that the procedure was safe or effective, violating ethical guidelines that require thorough understanding of risks before clinical use.
- **Exploitation of Vulnerable Populations:** Using couples affected by HIV raised concerns that vulnerable individuals were targeted, which goes against ethical principles that protect vulnerable groups from being unfairly used in research.
- **Scientific Integrity and Accountability:** Dr. He reportedly falsified documents to bypass ethical review processes, undermining scientific integrity and trust in the research community.
- **Lack of Global Bioethical Standards:** The incident exposed gaps in international oversight of gene-editing technologies and highlighted the need for unified global standards to regulate such powerful tools.
- **Cultural and Societal Impact:** The experiment sparked public debate about the acceptability of gene editing and emphasized the importance of involving society in decisions about how such technologies should be used.
- **Long-Term Consequences:** There are major ethical concerns about the unknown long-term effects on the genetically edited children and the responsibility scientists have toward future generations.

The field of human genetics still faces significant challenges. As technological advancements continue, researchers and ethicists must ensure that experiments involving germ line and even somatic genetic engineering are not conducted on humans unless there is assurance that they will not lead to harm or unforeseen consequences in individuals. Ultimately, genetic modification, similar to other technologies, was initially introduced to enhance human well-being. However, like many other innovations, it has the potential to be misused in ways that could be detrimental to humanity.

Surrogacy

Advances in reproductive technology have facilitated gestation, Surrogacy is a form of medically-assisted procreation (MAP) in which a woman "lends" her uterus to carry out a pregnancy on behalf of a third party.

Surrogacy can be categorized into two types: traditional and gestational. In traditional surrogacy, the surrogate mother is artificially inseminated with the intended father's sperm or donor sperm, using her own egg, making her the biological mother of the baby.



The traditional vs. gestational surrogacy

On the other hand, gestational surrogacy involves the surrogate woman carrying an embryo that is formed through in vitro fertilization (IVF), using eggs and sperm from donors or the intended parents, thus she shares no genetic link with the child. This approach is generally more expensive, and any unused embryos can be preserved for future attempts if the initial transfer is not successful (Storey, 2000).

The debates and challenges about surrogacy based on Igareda González (2020):

- ✓ **Exploitation**: There is a growing concern that surrogacy can be an exploitative practice, particularly for women in less economically developed countries. Critics argue that these women might be exploited as reproductive instruments, diminishing their dignity and treating them as commodities. The worry is that surrogates often come from disadvantaged backgrounds and may agree to surrogacy contracts due to financial pressures, exposing them to potential exploitation.
- ✓ **Free Consent:** The issue of whether surrogates are genuinely able to provide free and informed consent is crucial. There are doubts about the capacity of surrogates to make autonomous decisions, as societal and economic influences may affect

their choices. This raises ethical concerns about whether their consent is genuinely given or coerced.

- ✓ **Child Trafficking**: Another significant ethical concern is the possibility of surrogacy leading to child trafficking. Critics argue that the monetary aspect of surrogacy might commodify children, resulting in situations where they are treated as items for sale rather than individuals with rights and dignity. This brings up important ethical issues about the impacts on children's well-being and legal status.
- ✓ **Moral Pluralism and Global Inequities:** surrogacy might be seen as exploitation by wealthier "first-world" countries of poorer "third-world" countries. This global dynamic highlights issues of justice and fairness, as affluent individuals might pursue surrogacy in countries with less stringent laws, potentially taking advantage of social and economic disparities.

II.1.2 Interventions on the Human Body

Biotechnologies applied to the human body extend to various medical interventions and enhancements raise several issues:

Organ Transplantation

Organ transplantation is a medical process where an organ is moved from a donor to someone in need because their own organ is no longer working properly. The main goal of this procedure is to help patients regain their health and live longer, especially those facing severe organ failures from issues like kidney or liver problems, heart conditions, or serious lung diseases. Transplants can greatly enhance both the chances of survival and quality of life for these individuals, particularly when organs come from either deceased or living donors (Abouna, 2003).

Organ transplantation is faced with many ethical challenges:

- ✓ **Organ Distribution**: There are worries about the distribution of organs to patients, including how priority is determined and ensuring equal access. Ethical guidelines should steer the allocation process to ensure that those with the most urgent needs are the ones who receive transplant organs.
- ✓ **Consent to Donate**: The adoption of a 'presumed consent' system sparks ethical debates about whether it's right to assume individuals agree to donate their organs. Critics argue that this approach might infringe on personal freedom and could seem forceful.
- ✓ **Living Donors and Vulnerability:** Although living donations can boost organ availability, the ethical issues surrounding donors, especially minors and those financially disadvantaged, should not be overlooked. There is a potential for taking advantage of vulnerable individuals who might feel pressured to donate organs for monetary reasons.
- ✓ **Selling of Organs (organ black market):** The rise of a global market for human organs presents a major ethical challenge, especially when organs from poor donors are sold to wealthier buyers. This practice raises concerns about taking advantage of the less fortunate, inequality, and the morality of treating human organs as products.
- ✓ **Rewards for Donors:** There is ongoing discussion about whether it's morally right to offer rewards to living donors or the families of deceased donors. While covering expenses is generally accepted, providing financial incentives prompts worries about turning organ donation into a commercial transaction.

- ✓ **Advances in Medicine Utilization:** Ethical questions also arise concerning the use of stem cells, tissue engineering, and animal-to-human transplants (xeno-transpalntation). There is considerable debate over where stem cells come from and the ethical considerations of using animal organs in humans.
- ✓ **Honoring Cultural and Religious Beliefs**: Various cultural and religious perspectives can shape how people view organ donation and transplantation. Ethical systems must recognize and honor these different beliefs while encouraging organ donation efforts.

Reconstructive and Cosmetic Surgery

Plastic, reconstructive, and cosmetic surgeries encompass a range of procedures aimed at either repairing or restoring body parts to achieve a normal appearance or enhancing structures that are already considered normal. However, these procedures raise several ethical and moral concerns that require thorough examination (Sterodimas & Radwanski, 2011):

- ✓ **Patient Autonomy and Informed Consent:** This concept underscores the necessity of honoring patients’ rights to make educated choices regarding their bodies. Surgeons are responsible for making sure that patients fully grasp the potential risks, advantages, and options associated with procedures.
- ✓ **Beneficence and Non malficence:** The surgeons are obligated to act in the patients' best interests and prevent any harm. This involves a thoughtful assessment of the patients' mental and emotional preparedness for surgery.
- ✓ **Fair Access to Care:** The disparities in obtaining cosmetic surgery due to factors such as age, economic status, and cultural background, arguing that fair treatment is a fundamental human right.
- ✓ **Commercialization and Media Influence**: The rising demand for aesthetic surgeries has sparked ethical concerns about commercial practices. The influence of media in shaping public viewpoints and increasing consumer interest in cosmetic procedures raises moral questions regarding these impacts, plus these promotions can create unrealistic expectations and exploit vulnerable patient.
- ✓ **Competence and Ethical Standards:** There's a call for comprehensive training and certification for plastic surgeons to uphold high ethical standards. The potential for

exploitation and commercialism in cosmetic surgery demands careful oversight and ethical evaluation.

- ✓ **Complex Decision-Making:** The surgeons must skillfully manage various competing factors, including financial considerations and societal expectations, while maintaining a commitment to ethical practices in their work.

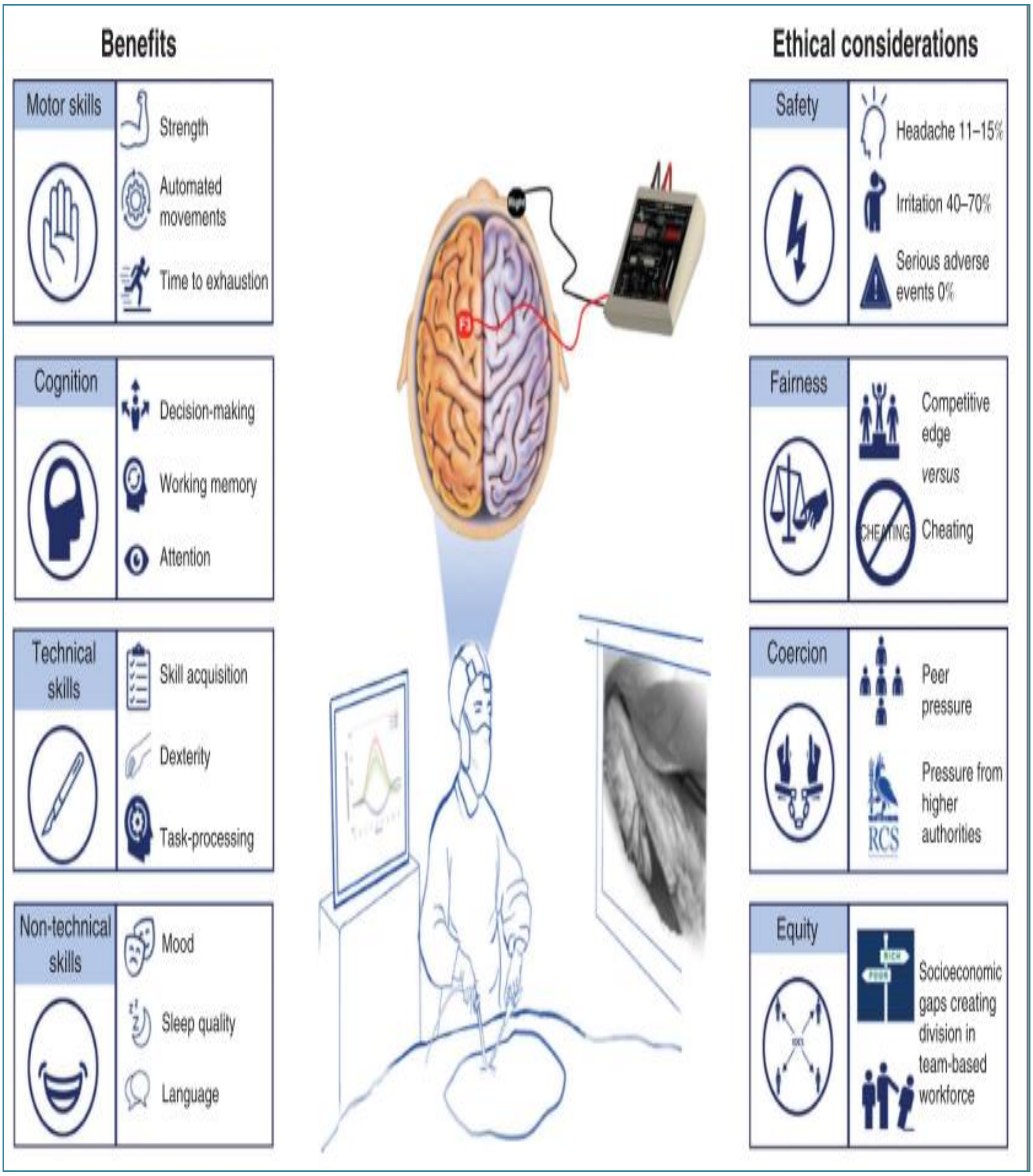
Atiyeh et *al.* (2020) urge a return to core medical values in cosmetic surgery, highlighting the essential Hippocratic principle of "do no harm." They stress that patient safety should always come first and criticize the increasing tendency of some practitioners to prioritize profit over genuine patient care. By nurturing a comprehensive understanding of patient needs and enhancing the doctor-patient relationship, aesthetic surgeons can push back against the commercialization of their practice. So there is a need for a shift towards a more medical-focused approach to aesthetic procedures, emphasizing ethical considerations and the healing nature of surgery to truly benefit patients.

Neuro-enhancement

Neuro-enhancement refers to the use of neurological interventions to improve cognitive function, mood, and physical abilities in healthy individuals, as opposed to solely treating diseases or disorders. The concept encompasses various methods, including pharmacological enhancements (such as stimulants and other medications) and non-pharmacological techniques (like neuro-stimulation) (Chatterjee, 2013).

The idea of "cosmetic neurology" comes from the growing trend of healthy people using techniques to boost their performance, similar to what happens in sports or academic settings. One example is transcranial direct-current stimulation (tDCS), a new method used to enhance brain function.

Studies show that tDCS can improve motor skills like reaction time, task completion, and strength, while also reducing fatigue. It also helps with cognitive abilities such as multitasking, focus, and attention. In surgery, tDCS has been shown to improve skills like tying knots, performing laparoscopic procedures, and using robotic tools, while also making surgeons feel less pressured by time (Patel et *al.*, 2020).



Potential advantages and ethical dilemmas surrounding the use of transcranial direct current stimulation on healthcare professionals to improve performance (Patel et *al*., 2020).

Nevertheless, neuro-enhancement rise several moral important implications (Chatterjee, 2013):

1. Safety: Enhancements may come with substantial side effects, ranging from mild to severe. Doctors are worried about the safety of these procedures, particularly when the risks might surpass the benefits for healthy people.

2. Character and Individuality: There is a worry that neuroenhancements could change fundamental aspects of a person's character and uniqueness. This brings up questions about the essence of being human and how such enhancements could affect personal identity.

3. Distributive Justice: The availability and accessibility of neuroenhancements can lead to inequalities. If only those who can afford these enhancements enjoy their benefits, it could increase socioeconomic disparities and raise concerns about fairness in access to advancements in cognitive and physical capabilities.

4. Coercion: There is a risk of coercion, particularly in competitive settings like academics and the military, where individuals might feel compelled to use enhancements to keep up with their peers or perform better. This can undermine personal autonomy.

5. Long-term Consequences: The long-term impacts of using enhancements on healthy individuals are largely unknown. This uncertainty raises an ethical issue about the possible unintended consequences of these interventions.

Bionic Prosthetics and Neural Interfaces

Brain-Computer Interfaces (BCIs), also referred to as brain-machine interfaces, are technologies that enable direct communication between the brain and external devices. These interfaces facilitate a bidirectional flow of information, allowing users to control devices such as robotic arms (bionic prosthetics), communication devices, or functional electronic stimulation systems by interpreting brain signals. The development and use of BCIs raise important ethical questions related to autonomy, privacy, agency, and the implications of integrating such technology into everyday life, including accessibility, costs, and the implications of merging human beings with machines (Klein & Nam, 2016).

II.1.3 Experimentation

Ethical considerations in human experimentation are critical:

Clinical Trials

The ethics surrounding clinical trials, particularly randomized controlled trials (RCTs), involve several key concerns that require careful thought (Nardini, 2014):

- ✓ **Risk vs. Benefit:** A central ethical challenge in RCTs is that the risks participants face might not be matched by direct benefits. These trials aim to generate broadly applicable medical knowledge rather than offer treatment to participants themselves. This creates a conflict between the risks taken and the potential advantages to the broader community.
- ✓ **Informed Consent:** Informed consent is a core ethical principle in clinical trials. Participants must fully understand the risks, benefits, and nature of the trial before agreeing to join. This principle is vital in helping participants make knowledgeable decisions about their involvement.
- ✓ **Use of Placebo:** The ethical considerations of using a placebo in trials are significant. While placebos can be crucial for determining a treatment's effectiveness, they also raise ethical issues about withholding treatment from participants who might benefit. This aspect is particularly contentious and requires thoughtful ethical analysis.
- ✓ **Randomization:** Randomization is a critical element of RCTs that helps prevent bias. However, it also presents ethical challenges, particularly in ensuring all participants have an equal chance of receiving potentially helpful treatments. The ethical principles surrounding randomization need to be thoroughly understood and communicated to participants.
- ✓ **Protection of Participants:** Ensuring the safety and well-being of participants is of utmost importance. Often, the individuals who benefit from the trial outcomes are not the same as those who bear the risks and burdens of participation. This discrepancy raises ethical concerns about the fairness and justice of clinical trials.
- ✓ **Increased Risk:** Participation in clinical trials often involves higher risk levels compared to standard medical care. Participants might face unexpected side effects from new treatments, necessitating a rigorous ethical review to ensure that risks are minimized and justified (Nardini, 2014).

- **Human Enhancement Research**

Research aimed at enhancing human abilities raises safety, consent, and unintended consequences issues.

Stem Cell Research

This area has sparked debate due to concerns over the destruction of embryos. However, guidelines and advancements in induced pluripotent stem cells help mitigate these concerns .

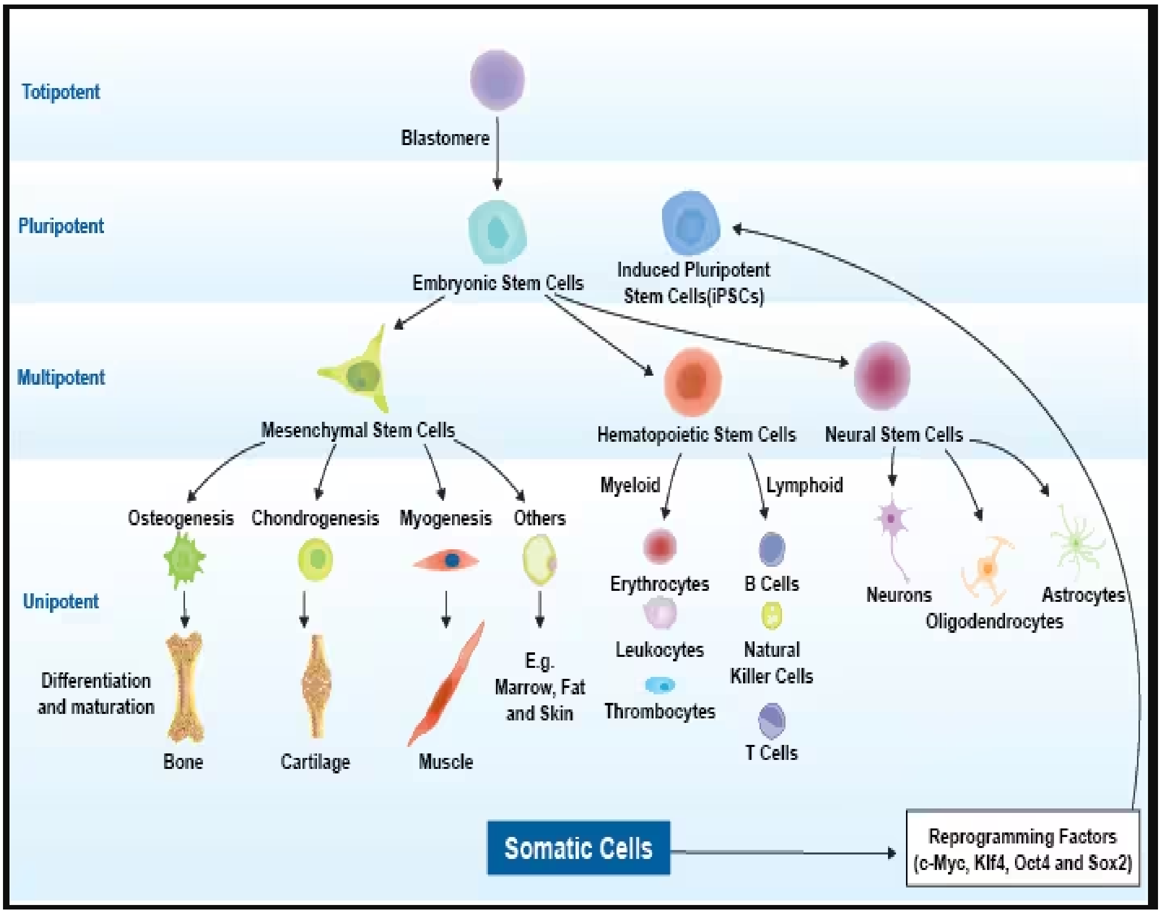


Image presenting the different types stem cells

Research on Vulnerable Populations

Studies involving vulnerable groups, such as prisoners or the mentally impaired necessitate extra ethical scrutiny to protect against exploitation.

II.2 Interventions on non-human beings and environments

Bioethics is about making good choices when it comes to living things and the world around us. It helps us think about how our actions can affect nature, like plants, animals, and ecosystems. We want to treat the environment with care and respect, so it stays healthy for the future. By following bioethics, we try to find ways to live in harmony with nature without causing harm.

II.2.1 Bioethics and Nature

Often referred to as environmental ethics or eco-bioethics, this branch addresses ethical questions about our responsibilities to the natural world and ecosystems. Key considerations include:

Biodiversity Conservation

Biodiversity conservation is about working together to protect the variety of life on Earth. This includes preserving genes, species, and ecosystems. It combines scientific knowledge, ethical ideas, economic and policy decisions, and practical management strategies to achieve this goal.

Ethical dilemmas arise when deciding how to protect biodiversity, as the loss of species and habitats due to human activities raises questions about our responsibilities to other species and the consequences of our actions on ecosystems. Additionally, the use of genetically modified organisms (GMOs) to restore ecosystems or revive extinct species introduces concerns about unintended consequences and the ethical implications of "playing God," highlighting the need for careful consideration of both ecological and moral factors in biodiversity conservation.

The De-extinction is the process of reviving extinct species, holds both potential benefits and significant risks for current ecosystems and biodiversity, the impacts are (Seddon & King, 2019):

1. **Uncertain Outcomes:** The potential impacts of de-extinct species remain uncertain; they may improve ecosystem function, or conversely, hinder conservation efforts and damage socio-ecological systems. This uncertainty poses a significant risk when introducing revived species into modern ecosystems.

2. **Competition with Existing Species** : New members of the ecosystem introduced via de-extinction could compete with existing species for resources, potentially pushing food sources to a breaking point and even driving other species to extinction
3. **Net Biodiversity Loss** : Extending the concept of extinction to ecosystem functional effects suggests that de-extinction could, paradoxically, lead to net biodiversity loss if revived species disrupt existing ecological networks
4. **Resource Diversion** : Focusing on de-extinction could compromise broader biodiversity goals by diverting resources from preserving ecosystems and preventing newer extinctions

Example: The Convention on Biological Diversity (CBD)

The Convention on Biological Diversity (CBD) is a comprehensive international treaty adopted in 1992 at the Earth Summit in Rio de Janeiro, Brazil. It is one of the most important global agreements aimed at protecting biodiversity.

It recognizes that biological diversity is about more than plants, animals and micro organisms and their ecosystems , it is about people and our need for food security, medicines, fresh air and water, shelter, and a clean and healthy environment in which to live *(The Convention on Biological Diversity, n.d)* .

The CBD has three primary goals:

1. Conservation of biological diversity (ecosystems, species, and genetic resources).
2. Sustainable use of its components.
3. Fair and equitable sharing of benefits arising from the use of genetic resources (including traditional knowledge).

Key Features :

- Global Participation: Over 196 countries are parties to the convention (all UN member states except the United States).
- National Action Plans: Countries are required to develop national strategies for conserving and sustainably using biodiversity.

- Protocols: The CBD includes supplementary agreements such as:
    - Cartagena Protocol on Biosafety (2000): Controls transboundary movement of genetically modified organisms (GMOs).
    - Nagoya Protocol on Access and Benefit-Sharing (2010): Ensures that benefits from genetic resources are shared fairly with source countries, especially indigenous communities.

Climate Change

Climate change refers to significant, long-term shifts in the usual weather patterns of a specific area, such as changes in temperature, rainfall, and wind, often caused by human activities that alter the earth's atmosphere.

These changes are occurring so rapidly that ecosystems are being transformed faster than many species can adapt. In which complicates the conservation efforts and forces difficult decisions about which species to prioritize and how to allocate limited resources.

Additionally, climate change ethics addresses questions of justice and responsibility, particularly focusing on the disproportionate impact on vulnerable communities and the obligations we have toward future generations. There several ethical challenges related to climate change and biodiversity conservation (Ikeke, 2021):

- **Moral Responsibility for Climate Change**: Climate change is a moral issue because it affects how humans should live in relation to non-human life. We all have an ethical responsibility to recognize our role in climate change and take action to reduce its impacts.
- **Intrinsic Value of Biodiversity**: Biodiversity has intrinsic value beyond its use as a resource for humans. It means that plants, animals, and ecosystems have their own inherent worth or importance, regardless of whether they are useful to humans or not.

  In other words, nature is valuable just because it exists, not only because it can provide food, medicine, materials, or other benefits to people. For example, a forest has intrinsic value simply because it exists and supports life within it, even if no human ever uses it for lumber, tourism, or any other purpose. So, this idea encourages us to respect and protect nature, not just for what it can do for us; but because it deserves care and preservation in its own right.

This raises ethical questions about humanity's duty to protect other species and ecosystems for their sake rather than just for human benefit.

- **Interconnectedness of Human and Non-Human Life**: the human life and biodiversity, are connected ,and emphasizing the importance of protecting the environment for the well-being of both humans and non-human entities
- **Justice and Equity in Environmental Policies**: Ethical concerns are raised regarding how climate change impacts disproportionately affect marginalized communities. Climate justice demands that policies ensure a fair distribution of the burdens and benefits of climate action, addressing inequalities in how climate impacts and responses affect different groups.
- **Public Perception, behavior and Moral Conviction**: Convincing individuals and societies of their moral obligation to act on climate change and biodiversity loss is a significant challenge. This requires overcoming psychological and socio-cultural barriers that prevent ethical action.

For instance, some individuals might concentrate solely on immediate needs, such as continuing to rely on inexpensive fossil fuels without considering the long-term consequences.

Others might feel powerless, thinking that their actions won't have any impact, or they might reject the realities of climate change due to misinformation or their cultural views. Take, for example, a community where owning a car is a sign of success; people might be reluctant to switch to public transport, even though it's more environmentally friendly. Cultural standards, a lack of understanding, or conflicting priorities like economic development can also pose challenges for societies trying to make ethical decisions. It is crucial to modify ethical behavior. There is a need for an ethical reevaluation of human practices that cause environmental degradation, along with a shift toward adopting lifestyles aligned with sustainable values.

Land Use and Resource Allocation

Land Use Ethics refers to the moral principles and values that guide decisions and actions related to the allocation, management, and utilization of land resources (*Land Use Ethics*, n.d.).

It emphasizes responsible stewardship, balancing economic development with environmental protection and social equity, particularly within the framework of sustainability. This ethical framework considers the long-term impacts of land use practices on ecosystems, communities, and future generations, promoting practices that minimize harm and maximize benefits for all stakeholders.

Sustainability: Within the context of sustainability, land use ethics is vital for ensuring that land resources are managed in a way that meets the needs of the present without compromising the ability of future generations to meet their own needs. It promotes practices that conserve biodiversity, protect ecosystem services, and mitigate climate change. Sustainable land use ethics also addresses issues of social justice, ensuring equitable access to land and resources, and preventing displacement or marginalization of vulnerable communities.

Applications: land use ethics finds application in various domains, including urban planning, agriculture, forestry, and conservation. In urban planning, it guides the development of compact, walkable, and transit-oriented communities that reduce reliance on automobiles and minimize sprawl.

In agriculture, it promotes sustainable farming practices that conserve soil, water, and biodiversity. In forestry, it supports responsible forest management that balances timber production with ecosystem protection. In conservation, it informs the establishment and management of protected areas that safeguard biodiversity and ecosystem services.

Resource allocation can be defined as the distribution of available resources such as land, water, and financial capital among individuals and nations to achieve a balance that meets the needs of society, particularly in the context of environmental sustainability and social equity.

The current practices in resource allocation are disproportionately favoring wealthier populations, exacerbating inequities and environmental degradation.

It argues that a more equitable and sustainable approach to resource allocation is essential for preserving the biospheric life support system and ensuring the stability and survival of human society,

II.2.2 Bioethics in Animal Experimentation

Ethical considerations in animal experimentation are essential for ensuring the welfare of research animals while advancing scientific knowledge, we've seen in chapter 1the most important key principles :(Kiani et al., 2022):

Reduction, Replacement, and Refinement (3Rs)

proposed by William M. S. Russell and Rex L. Burch in 1959, 3Rs principles are widely adopted framework aims to promote animal welfare by: replacing animals and seeking alternatives wherever feasible with another means of experimentation; reducing (minimizing) the number of animals used to the minimal needed to obtain scientifically valid results; and to refine experiments to avoid unnecessary harm to animals and reduce their suffering (*The 3Rs | NC3Rs*, n.d.).

However, this framework does not provide guidance on which experiments should take place. In this regard, Beauchamp and DeGrazia proposed six principles of morally justified research, which need to be satisfied for an animal experiment to be conducted. By integrating social benefit and animal welfare into a unified framework, they aim to modernize ethical standards while balancing scientific progress and ethical accountability (Degrazia & Beauchamp, 2019).

The proposed principles are:

a. no alternative method to animal testing exists,
b. an expected net benefit to humans,
c. the experiment provides sufficient value to justify the harm caused to animals,
d. animals are not subjected to unnecessary harm,
e. basic needs of animals are met,
f. there are upper limits to the harm allowable in an experiment

IACUC/ AEC Oversight

Animal Ethics Committees, such as Institutional Animal Care and Use Committees (IACUCs) and Animal Ethics Committees (AECs), play a critical role in bioethics by ensuring the humane and ethical treatment of animals used in research. They are responsible for evaluating research proposals to assess compliance with ethical standards, regulatory requirements, and the principles of the 3Rs.

By carefully reviewing whether animal studies are scientifically necessary and ensuring proper animal care, these committees help safeguard animal welfare, encourage ethical research, and build public confidence in science. Their decisions not only impact animal welfare but also reflect broader ethical considerations regarding the balance between scientific advancement and moral responsibility.

These committees face several challenges that affect their decision-making processes. One major issue is the lack of clear guidelines for conducting harm-benefit analyses, which makes it difficult for members to assess the potential benefits of research against the harms to animals. Additionally, the composition of many committees tends to be imbalanced, with a predominance of scientists and veterinarians, which can lead to a focus on technical aspects rather than ethical considerations. This imbalance, along with limited expertise in certain areas, can hinder thorough evaluations (Milford et *al.*, 2025).

Furthermore, the dynamics within committees can influence discussions, leading to dominant voices overshadowing less assertive members, particularly in cases of differing opinions. There is also pressure from funding sources to approve projects that have been financially supported, potentially compromising ethical reviews. Training gaps among committee members on ethical frameworks and the subjectivity involved in assessing harms and benefits further complicate their evaluations. These challenges collectively hinder the committees' ability to ensure the protection of animal welfare in research practices (Milford et *al.*, 2025).

Chapter III: Ethics and Biology

This chapter explores how biological advancements challenge and reshape ethical frameworks, examining their impact on human identity, morality, and societal norms. Students will analyze intersections between biology and ethics through topics like neuroscience (e.g., brain-morality links), genetics (e.g. behavioral genetics), and environmental ethics (e.g., biodiversity, climate responsibility). It also addresses risks such as bioweapons and biosecurity.

A dedicated section focuses on Algeria's legal landscape , reviewing regulations for genetic technologies like pre-implantation diagnosis, prenatal screening, and cancer-related genetic testing.

By integrating scientific, cultural, and legal perspectives, this chapter equips students to critically evaluate how biological discoveries demand ethical reflection to uphold human dignity, equity, and sustainable practices.

III.1 The Impact of Biology on Ethics

The impact of biology on ethics refers to how biological knowledge, discoveries, and advancements influence our understanding of moral principles, values, and the ethical dilemmas that arise in science, medicine, and society. As biology progresses; especially in fields like genetics, neuroscience, reproductive technologies, and biotechnology, it challenges traditional ethical frameworks and forces individuals and societies to rethink what is right or wrong, acceptable or unacceptable. Several key areas illustrate this impact:

Understanding Human Nature

Insights from biology, particularly evolutionary psychology, reveal how our biological heritage shapes moral intuitions and social behaviors. This perspective aids in exploring the origins of ethical principles and moral judgments.

For example, Ayala, (2009) in his paper "What the Biological Sciences Can and Cannot Contribute to Ethics" explores the relationship between biology and ethics, asserting that while the capacity for ethical behavior is a fundamental attribute of human nature, the specific moral norms that guide human actions are products of cultural evolution , not biological evolution.

Neuroscience and Morality

Advances in neuroscience provide evidence of specific brain regions involved in moral reasoning and ethical decision-making. Research indicates that our moral judgments may be influenced by biological factors, prompting discussions about free will and moral responsibility. Using fMRI studies, Greene found that: Emotionally charged moral dilemmas activate brain areas linked to emotion and social cognition, such as the amygdala , insula , and medial prefrontal cortex . Impersonal dilemmas engage brain regions associated with reasoning and cognitive control , like the dorsolateral prefrontal cortex (DLPFC) (Greene, 2009).

This work challenges traditional philosophical views of morality as purely rational or rule-based. It supports the idea that morality is rooted in biology, shaped by evolution, and mediated by distinct neural systems.

Genetics and genomics

The rise of genetic research introduces ethical dilemmas concerning genetic determinism and technologies like CRISPR-Cas9. The ability to modify human DNA raises questions about "designer babies," consent, and unintended consequences. These developments necessitate discussions about moral responsibility in light of our genetic makeup.

Environmental Ethics

Biological insights into ecosystems and biodiversity are crucial for ethical discussions surrounding conservation and sustainability, emphasizing our obligations to future generations.

Medical Ethics

Progress in biomedicine transforms medical ethics, engaging with complex issues such as genetic testing, gene therapy, and end-of-life decisions, all deeply rooted in biological understanding.

Animal Ethics

Increasing knowledge about animal cognition and sentience raises ethical considerations regarding our treatment of non-human animals, prompting debates about animal rights and welfare.

For example, the relationship between humans and their pet dogs is complicated and often not equal. Even though we see dogs as loyal friends or even part of the family, this connection is shaped by the control humans have over them. We decide where they live, what they eat, how they act, and how we emotionally interact with them. Dogs have lived alongside humans for a long time and are very good at understanding our behavior, how we communicate, and even our emotions.

Comparative cognition research shows that dogs have remarkable social and cognitive abilities, especially in understanding human gestures, emotions, and intentions. Because of this, we cannot look at the human-dog bond in a romantic or idealized way. It also comes with ethical responsibilities. Since humans are in charge and play a dominant role in shaping the dogs' lives, we must think about their emotional health, their freedom to make choices (autonomy), and the serious moral responsibility that comes with the strong bonds we build with them (Benz-schwarzburg et *al.*, 2020).

Biosecurity and Bioweapons

Bio-security is the protection, control of, and accountability for high-consequence biological agents and toxins, and critical relevant biological materials and information within laboratories to prevent unauthorized possession, loss, theft, misuse, diversion, and intentional release

The relationship between bioethics and biosecurity involves the ethical oversight of the deliberate control and protection of biological agents to prevent their misuse.

Bioethics provides a framework for evaluating the moral implications of biosecurity measures, such as ensuring responsible conduct in handling high-consequence biological materials, balancing security concerns with ethical principles, and promoting transparency and accountability.

While biosecurity primarily focuses on preventing theft, misuse, or intentional release of dangerous biological agents, bioethics guides how these security practices are implemented ethically, considering issues like the rights of researchers, the responsible sharing of information, and the societal implications of security policies. Therefore, bioethics plays a crucial role in shaping biosecurity policies to ensure they are morally justifiable, equitable, and respect human rights, especially in areas like dual-use research where scientific benefits might conflict with security risks.

For instance, during the COVID-19 pandemic, there were ethical issues highlighted by the importance of biosafety and biosecurity (Resnik, 2024):

1. **Responsibility and Transparency**: Ethical concerns about the transparency of laboratories and governments regarding data, research activities, and possible biosafety lapses, especially related to the virus's origins.
2. **Risk of Accidents and Misuse**: Moral obligations to prevent accidental releases of dangerous pathogens and restrict misuse of sensitive biological materials, balancing scientific progress with safety.
3. **Dual-Use Research of Concern (DURC)**: Ethical dilemmas surrounding research that has the potential for beneficial applications but could also be used maliciously, such as gain-of-function studies.
4. **Justice and Fairness**: Ensuring equitable access to vaccines, treatments, and research benefits, and fair governance of high-consequence biological materials.
5. **Public Trust and Morality**: Maintaining public trust through responsible communication, adhering to safety standards, and preventing any view that research is conducted irresponsibly or with hidden motives.
6. **Global Responsibility**: The ethical need for international cooperation and governance to address global biological risks and prevent future pandemics.

Black Biology refers to the unethical application of genetic engineering techniques to enhance the virulence of pathogens or to target specific genetic codes for malicious purposes such as bioterrorism (Lawrence, 2013). This form of biological manipulation poses a serious threat to public health and global security, as it involves the deliberate alteration of microorganisms to make them more dangerous, more resistant to treatment, or more targeted in their effects.

A notable historical example of Black Biology was the research conducted by Sergei Popov , a leading scientist in the Soviet Union's biological weapons program. Popov reported developing genetically modified strains of deadly pathogens, including a version of the plague resistant to multiple antibiotics and an anthrax strain that could evade both the anthrax vaccine and several antibiotic treatments. His work exemplifies how scientific advancements can be misused to create biological agents with enhanced danger, turning tools meant for healing into instruments of harm (Lawrence, 2013).

The development and use of biological weapons raise profound ethical concerns, particularly for scientists working in microbiology. Such activities contradict the core principles of medical ethics, especially the fundamental duty to *do no harm*. Scientists are expected to apply their knowledge to improve human health, not to create tools of mass suffering.

From a bioethical perspective**, biological weapons** are condemned as inherently immoral due to their indiscriminate threat to life and their alignment with "antisurvival" activities like war. These weapons do not distinguish between military targets and innocent civilians, and once released, they can spread uncontrollably, and causing widespread suffering and long-term consequences. The 2001 anthrax attacks in the U.S. were a shocking example of bioterrorism. Shortly after 9/11, letters containing dangerous anthrax spores were sent through the mail to media offices and politicians. This caused 5 deaths and 17 infections, showing how dangerous it is to misuse biology as a weapon (Anaya-velázquez, 2002).

The global scientific community, particularly microbiologists, has a crucial responsibility to oppose the misuse of microorganisms as biological weapons. At the same time, they must actively promote the principle that the ethical and responsible use of microorganisms is not just a professional obligation, but a moral imperative for all scientists worldwide. This is essential because biological weapons pose a serious threat to human life, public health, and global security.

III.2 Behavioral Genetics Research

Behavioral genetics is defined as research that strives to understand the genetic basis and contribution to human behavior, including a wide range of actions and responses of an organism to its environment ,so, it will undoubtedly further our understanding of normal human variation in many behavioral traits, such as personality, intelligence (cognitive processes), and sexuality (DeCamp & Sugarman, 2004) .

Behavioral genetics research presents significant ethical considerations that must be addressed to ensure responsible conduct and ethical treatment of individuals involved. Key bioethical issues include (Berryessa & Cho, 2013):

1. **Genetic Determinism and Free Will**: Concerns those genetic explanations for behavior may undermine notions of individual responsibility and free will, emphasizing that behavior results from a complex interaction of genetics and environment.
2. **Discrimination and Stigmatization**: Risk of societal or institutional bias against individuals or groups based on genetic predispositions.
3. **Privacy, Consent and Confidentiality**: Issues surrounding the privacy of genetic information and the informed consent of individuals, it demands strict measures to protect the privacy and confidentiality especially in prenatal or forensic contexts.
4. **Potential for Misuse**: Use of genetic data to justify eugenics-like policies or bias, reminiscent of historical eugenics movements.
5. **Vulnerable Populations**: Ethical challenges in applying genetic research to vulnerable groups such as children, pregnant women, and incarcerated individuals.
6. **Psychological Impact**: Participants may experience emotional distress upon learning about genetic predispositions. Researchers have a duty to provide adequate support to those affected
7. **Justice and Fairness**: Ethical research mandates that benefits be distributed fairly, avoiding disproportionate advantages to specific groups while neglecting others , potentially leading to biased or unequal treatment in legal and social contexts
8. **Technology and Applications**: Ethical concerns about emerging technologies like gene editing, noninvasive prenatal testing, and genetic enhancement, including their social and moral implications.

Bioethics plays a crucial role in guiding behavioral genetics research by addressing the complex moral, social, and legal issues that arise from advances in genomic technologies. It helps ensure that research practices respect individual rights, promote justice, and prevent discrimination, while fostering responsible application of genetic knowledge.

Through ethical frameworks and public engagement, bioethics seeks to balance scientific progress with societal values, safeguarding individuals and communities from potential harms associated with genetic determinism, eugenics, and privacy concerns, thus promoting culturally sensitive and equitable advancements in the field.

III.3 Bioethics and Algeria

Over the past few decades, Algeria has made significant strides in addressing bioethical issues, reflecting a growing alignment between modern scientific advancements and its cultural and legal frameworks. The integration of bioethics into medical and biological sciences curricula since 2011 marks a pivotal shift, with ethics modules now embedded in undergraduate and postgraduate programs to foster critical thinking among students and professionals alike (Debab et *al*., 2024).

Bioethics in Algeria is governed by a specific legislative framework that has evolved over the years to address ethical issues in the medical and biological fields. Here are the key points regarding bioethics in Algerian law:

1. **Initial Legislation**: The term "Medical Ethics" was first introduced in Algerian law with Law No. 90-17 on July 31, 1990. This law modified and supplemented previous regulations related to health protection and promotion.

2. **Establishment of Ethical Bodies**: The National Council for Ethics in Health Sciences (CNESS) was created in 1990 to address ethical issues, particularly those related to human organ transplants and experimentation on human subjects.

3. **Recent Developments**: The legal framework was significantly updated with the promulgation (implementation) of Law No. 18-11 on July 2, 2018. This law repealed earlier laws and introduced a dedicated section on "ETHICS, DEONTOLOGY, AND MEDICAL BIOETHICS," which includes 46 articles outlining various aspects of bioethics.

The new law delineates four main areas of bioethics:

- **Organ and Tissue Transplantation**: The law details the procedures for the removal and transplantation of human organs and tissues. It emphasizes the importance of voluntary and informed consent, the ethical handling of donor and recipient data, and compliance with international standards to prevent illegal organ trade or exploitation
- **Rights of Blood Donors:** It establishes principles related to the donation of blood, safeguarding the rights of donors, including informed consent, confidentiality, and voluntary participation. The law aims to promote ethical blood donation practices and prevent coercion or commercialization.
- **Medically Assisted Procreation:** Provisions concerning assisted reproductive technologies (ART) are outlined, addressing ethical issues such as donor anonymity (restricted and typically only available within the framework of legal marriage, with strict regulations that do not recognize donor anonymit), parentage, and the welfare of the child. The law seeks to regulate ART procedures to uphold ethical standards and protect the rights of all parties involved.
- **Biomedical Research:** The law sets standards for ethical biomedical research, including requirements for ethical approval, informed consent, protection of vulnerable populations, and compliance with international guidelines. It aims to ensure that research activities respect human rights and scientific integrity

Scope on some legal framework regarding genetic testing in Algeria

The Algerian legal framework regarding genetic testing is primarily informed by broader bioethics regulations and international declarations, with specific statutes emphasizing confidentiality and the ethical handling of genetic data, here are some cases (Derdour, 2024):

Pre-implantation Diagnosis (PGD): Algerian law prohibits genetic selection, such as sex selection or selecting embryos based on genetic traits, as outlined in Article 436 of Law 18-11 (2018) : "Anyone who contravenes the prohibition set out in the provisions of Article 375 of this law, relating to the reproduction of living organisms, genetically identical and sex selection, shall be punished by imprisonment of ten (10) to twenty (20) years and a fine of

1,000,000 DA to 2,000,000. DA *"Law No.18-11, dated July 2, 2018, concerning health, Official Journal No. 46, issued on July 29, 2018, amended and supplemented by Ordinance No. 20-02 of August 30, 2020, Official Journal No. 50 of August 30,2020.*

This prevents the use of PGD for non-medical trait selection, focusing its application on preventing the transmission of serious genetic diseases.

Prenatal Diagnosis: The law permits prenatal genetic testing for diagnosing genetic diseases, especially in cases where it can inform decisions about pregnancy. However, the decision to terminate a pregnancy based on such diagnoses is ethically and legally complex, with restrictions; **abortion** is only allowed when the mother's life is in danger, and therefore decisions based on genetic abnormalities are limited. "Anyone who, through food, drink, medication, maneuvering, violence or any other means, has procured or attempted to procure the abortion of a pregnant or supposedly pregnant woman, whether she has consented to it or not, is punishable by imprisonment of between one (1) and five (5) years and a fine of between five hundred (500) and ten thousand (10,000) DA. If death results, the penalty is ten (10) to twenty (20) years' imprisonment. In all cases, the guilty party may also be subject to a residence ban." *Ordinance No. 66-166, dated June 8, 1966, related to penal code, Official Journal No. 49, amended and supplemented by Ordinance No. 20-06 of April 28, 2020, Official Journal No. 25 of April 29, 2020*

Article 304 of Ordinance no. 66-166 of June 8, 1966 on the Penal Code has been, amended and supplemented. As for article 308, abortion is not punishable when it constitutes an essential measure to save the life of the mother in danger and is performed openly by a doctor or surgeon after advice has been given.

Cancer and Post-Natal Diagnosis: Genetic testing for cancer (e.g., breast cancer) and post-birth diagnosis are recognized as valuable tools for early detection and management. The law supports the use of genetic testing to inform clinical decisions, assess risks, and guide therapeutic strategies, with confidentiality and ethical considerations emphasized to protect patient rights.

Algerian bioethics law, rooted in Islamic principles and influenced by the Maliki school of Islamic jurisprudence , addresses modern issues like genetic modification and eugenics through the lens of preserving human dignity and adhering to Sharia ethics. While the Maliki school does not explicitly mention these technologies, it emphasizes the sanctity of human life and prohibits actions that violate divine intent or harm human integrity (Aouadi, 2015).

Genetic interventions are conditionally permissible if they aim to prevent suffering (e.g., correcting genetic disorders) without compromising dignity or moral values. However, practices deemed exploitative, harmful, or contrary to Islamic teachings such as altering God’s creation for non-therapeutic enhancement,are considered impermissible (Aouadi, 2015).

Thus, Algerian regulations on genetic technologies balance scientific progress with ethical boundaries derived from Maliki jurisprudence, prioritizing human welfare and alignment with Islamic moral frameworks ,although the Algerian law is still developing, current provisions underscore the importance of protecting individuals' genetic information, especially to prevent misuse, discrimination, or eugenics.

Table :Summary of Algerian bioethics law (law18-11)

AREA	LEGAL STATUS	KEY RULE
PGD	Permitted	Only for serious genetic disease ,NO sex selection
Prenatal Diagnosis	Permitted	Abortion only if mother’s life is at risk
Organ Donation	Permitted	Free, voluntary , no commercialization
Genetic Testing	Permitted	Confidentiality required ,no discrimination
CRISPR/Germline Editing	Prohibited	Up to 20 years imprisonment (Art. 436)

Conclusion

Bioethics is essential for ensuring that science and medicine serve humanity with autonomy, justice, beneficence, and non-maleficence. It protects people’s rights, stops exploitation, and ensures research is honest and trustworthy. It also balances new discoveries with safety, helps vulnerable groups, and builds public trust in science. Ethical rules let scientists work together globally and adapt to new challenges like genetic engineering.

In Algeria, bioethics is growing, with laws like Law No. 18-11 (2018) and institutions such as the National Council for Ethics in Health Sciences (CNESS) leading the way. However, challenges remain, such as improving enforcement and addressing cultural concerns around issues like organ donation.

As future scientists, doctors, or leaders, your role is to use bioethics to ask tough questions, challenge unethical practices, and ensure science benefits everyone,fairly, safely, and kindly. Let this course be your starting point.

Glossary of abbreviations

ABBREVIATION	FULL NAME	DETAILED EXPLANATION
AI	Artificial Intelligence	Refers to computer systems capable of performing tasks that typically require human intelligence, such as decision-making, pattern recognition, and language processing. In bioethics, AI raises concerns about data privacy, algorithmic bias, informed consent in digital health, and the delegation of clinical decisions to non-human agents.
AEC	Animal Ethics Committee	A review body responsible for evaluating and approving research protocols involving animals. AECs ensure compliance with ethical standards, animal welfare regulations, and the 3Rs principles (Replacement, Reduction, Refinement).
ART	Assisted Reproductive Technology	A set of medical procedures used to treat infertility, including In Vitro Fertilization (IVF),Intracytoplasmic Sperm Injection (ICSI),Gamete Intrafallopian Transfer (GIFT), andartificial insemination. ART raises ethical issues related to embryo status, donor anonymity, surrogacy, and the potential for “designer babies.”
BCI	Brain-Computer Interface	A system that enables direct communication between the brain and an external device (e.g., robotic limbs, computers). BCIs are used in neuroprosthetics and neuroenhancement. Ethical concerns include privacy of neural data, identity alteration, cognitive liberty, and potential misuse in military or commercial contexts.
CIOMS	Council for International Organizations of Medical Sciences	An international non-governmental organization established in 1949 under the joint auspices of WHO and UNESCO. CIOMS develops international ethical guidelines for biomedical research involving human subjects, especially in low-resource settings. Its guidelines complement the Declaration of Helsinki and emphasize protection of vulnerable populations .
CRISPR	Clustered Regularly Interspaced Short Palindromic Repeats	A revolutionary gene-editing technology that allows precise modification of DNA sequences. Often used with the enzyme Cas9 (henceCRISPR-Cas9). While promising for curing genetic diseases, it poses ethical dilemmas regarding germline editing, eugenics, consent, and irreversible changes to the human gene pool (e.g., the He Jiankui case).

DLPFC	Dorsolateral Prefrontal Cortex	A region of the brain involved in executive functions, such as reasoning, decision-making, and cognitive control. In neuroscience and bioethics, it is studied in relation to moral judgment particularly in impersonal ethical dilemmas where rational deliberation overrides emotional responses.
DURC	Dual-Use Research of Concern	Scientific research that, while intended for legitimate purposes, could be misapplied to threaten public health, safety, or security(e.g., gain-of-function studies on pathogens). Bioethics demands strict oversight of DURC to balance scientific openness with biosecurity.
ECT	Ectogenesis	The development of an organism in an artificial womb outside the human body. Though not explicitly abbreviated in the text, it is discussed under “Artificial Wombs and Ectogenesis.” Raises ethical questions about pregnancy, parental rights, disability, and the redefinition of birth.
GIFT	Gamete Intrafallopian Transfer	A type of ARTwhere eggs and sperm are placed directly into a woman’s fallopian tube to allow fertilization to occur inside the body(unlike IVF, which occurs in a lab). Less commonly used today but still relevant in bioethical discussions about embryo creation and natural conception.
IACUC	Institutional Animal Care and Use Committee	A U.S.-based oversight body required by law to review and approve all research involving animals at institutions receiving federal funding. IACUCs enforce theAnimal Welfare Actand the3Rs, ensuring humane treatment and scientific justification.
ICSI	Intracytoplasmic Sperm Injection	A specialized form of IVF where a single sperm is injected directly into an egg. Used in cases of severe male infertility. While effective, it bypasses natural selection mechanisms, raising questions about long-term genetic and developmental outcomes.
IVF	In Vitro Fertilization	A foundational ART technique where fertilization occurs outside the body(“petri dish”) in a laboratory dish. Ethically contentious due to the creation, storage, and potential destruction of surplus embryos.
LMICs	Low- and Middle-Income Countries	Nations with limited financial resources, often facing challenges in healthcare access, research infrastructure, and regulatory capacity. The 2024 Declaration of Helsinki emphasizes equitable inclusionof LMICs in research and fair

		benefit-sharing.
PVS	Persistent Vegetative State	A condition of severe brain damage where a patient is awake but shows no signs of awareness or cognitive function. Central to landmark bioethics cases like Karen Ann Quinlan,Nancy Cruzan, and Terri Schiavo, which shaped legal and ethical frameworks for end-of-life decisions and surrogate consent.
PGD	Preimplantation Genetic Diagnosis	A technique used during IVF to screen embryos for genetic disorders before implantation. While used to prevent serious hereditary diseases, PGD raises concerns about eugenics, trait selection, and the moral status of embryos. In Algeria, PGD is permitted only for medical purposes; non-medical selection is criminalized.
SNC	Système Nerveux Central (Central Nervous System)	The French abbreviation used in the cancer types section to refer to brain and spinal cord tumors (e.g.,gliomas,meningiomas).
UNESCO	United Nations Educational, Scientific and Cultural Organization	A specialized UN agency that promotes international collaboration in education, science, and culture. UNESCO adopted the Universal Declaration on Bioethics and Human Rights (2005), the first global intergovernmental instrument establishing universal bioethical principles.
USPHS	U.S. Public Health Service	The federal agency that conducted theTuskegee Syphilis Study (1932–1972), a notorious example of unethical research involving vulnerable populations. The study led to theBelmont Report (1979)and modern regulations for human subjects research.
WMA	World Medical Association	An international confederation of national medical associations, founded in 1947. The WMA adopted the Declaration of Helsinki (1964) and continues to revise it as the global ethical standard for physicians conducting research.

Bibliography

1. Abouna, G. M. (2003). Debate : Medical Ethics Series 1 Ethical Issues in Organ Transplantation. 19087, 54–69. https://doi.org/10.1159/000068158
2. Anaya-velázquez, F. (2002). Bioethics, bioweapons and the microbiologist. 44(1), 38–45.
3. Aouadi, Z. (2015). human Genetic Engineering Between the Religious Vision and Legal Framework". Journal of Scientific Research and Islamic Studies", 8, 140–172.
4. Atiyeh, B. S., Rubeiz, Æ. M. T., & Hayek, S. N. (2020). Aesthetic / Cosmetic Surgery and Ethical Challenges. Aesthetic Plastic Surgery, 1364–1374. https://doi.org/10.1007/s00266-020-01821-z
5. Ayala, F. (2009). "What the Biological Sciences Can and Cannot Contribute to Ethics." Contemporary Debates in Philosophy of Biology. Oxford: Wiley-Blackwell., 1–46.
6. Ayanoğlu, F. B., Elçİn, A. E., & Elçİn, Y. M. (2020). Bioethical issues in genome editing by CRISPR-Cas9 technology. Turkish Journal of Biology, 44(2), 110. https://doi.org/10.3906/BIY-1912-52
7. Aznar, J., & Tudela, J. (2020). Bioethics of Assisted Reproductive Technology. Innovations In Assisted Reproduction Technology. https://doi.org/10.5772/INTECHOPEN.90727
8. Baños, J. E., & Guardiola, E. (2023). History of Bioethics. Bioethics: Foundations, Applications and Future Challenges, 19–32. https://doi.org/10.1201/9781003269885-3/HISTORY-BIOETHICS-JOSEP-BA
9. Beauchamp, T. (2008). The Principle of Beneficence in Applied Ethics. https://plato.stanford.edu/Entries/principle-beneficence/#BeneBiomEthi
10. Benz-schwarzburg, J., Monsó, S., & Benz-schwarzburg, J. (2020). How Dogs Perceive Humans and How Humans Should Treat Their Pet Dogs : Linking Cognition With Ethics. 11(December). https://doi.org/10.3389/fpsyg.2020.584037
11. Berryessa, C. M., & Cho, M. K. (2013). Ethical, Legal, Social, and Policy Implications of Behavioral Genetics. Annu Rev Genomics Hum Genet, 14, 515–534. https://doi.org/10.1146/annurev-genom-090711-163743.Ethical
12. Bibbins-Domingo, K., Brubaker, L., & Curfman, G. (2025). The 2024 Revision to the Declaration of Helsinki: Modern Ethics for Medical Research. JAMA, 333(1), 30–31. https://doi.org/10.1001/JAMA.2024.22530
13. Callahan, D. (1999). The Hastings Center and the Early Years of Bioethics. Kennedy Institute of Ethics Journal, 9(1), 53–71. https://doi.org/10.1353/KEN.1999.0001
14. Callicott, J. B. (2021). The Land Ethic and the Earth Ethic(s). Ethics, Policy & Environment, 24(1), 27–43. https://doi.org/10.1080/21550085.2021.1904532

15. Campbell, L. (2017). Kant, autonomy and bioethics. Ethics, Medicine and Public Health, 3(3), 381–392. https://doi.org/10.1016/J.JEMEP.2017.05.008
16. Chatterjee, A. (2013). The ethics of neuroenhancement. In Handbook of Clinical Neurology (Vol. 118, pp. 323–334). Elsevier. https://doi.org/10.1016/B978-0-444-53501-6.00027-5
17. Chen, Q., Ma, Y., Mills, P., Labude, M., Schaefer, G. O., & Xafis, V. (2024). Making sense of it all : Ethical reflections on the conditions surrounding the first genome-edited babies. 1–20.
18. CIOMS. (2002). International Ethical Guidelines for Biomedical Research Involving Human Subjects Prepared by the Council for International Organizations of Medical Sciences. Cioms, 150.
19. CIOMS. (2016). Council for International Organisation of Medical Sciences (CIOMS). In Dictionary of Pharmaceutical Medicine. https://doi.org/10.1007/978-3-211-89836-9_313
20. Debab, Z. B., Heroual, N., Idder, A., Sahraoui, T., Aboubekeur, A., Layadi, K., & Elkebir, F. Z. (2024). Teaching of bioethics in the field of medical and biological sciences : The situation in Algeria Teaching of bioethics in the field of medical and biological sciences : The situation in Algeria. January. https://doi.org/10.53771/ijbpsa.2024.7.2.0043
21. DeCamp, M., & Sugarman, J. (2004). Ethics in Behavioral Genetics Research. Accountability in Research: Policies and Quality Assurance, 11(1), 27–47. https://doi.org/10.1080/725289013
22. Declaration of Helsinki Revision Process 2024 – WMA – The World Medical Association. (n.d.). Retrieved April 9, 2025, from https://www.wma.net/fr/declaration-of-helsinki-revision-process-2024-2/
23. Degrazia, D., & Beauchamp, T. L. (2019). Beyond the 3 Rs to a More Comprehensive Framework of Principles for Animal Research Ethics. ILAR Journal, 60(3), 308–317. https://doi.org/10.1093/ILAR/ILZ011,
24. Deontological Ethics (Stanford Encyclopedia of Philosophy). (n.d.). Retrieved April 10, 2025, from https://plato.stanford.edu/entries/ethics-deontological/
25. Derdour, S. N. (2024). Genetic Testinf and Bioethics. Critical Journal of Law and Political Sciences, 19(19), 112–126.
26. Emanuel, E. J., Persad, G., Upshur, R., Thome, B., Parker, M., Glickman, A., Zhang, C., Boyle, C., Smith, M., & Phillips, J. P. (2020). Fair Allocation of Scarce Medical Resources in the Time of Covid-19. New England Journal of Medicine, 382(21), 2049–2055. https://doi.org/10.1056/NEJMSB2005114/SUPPL_FILE/NEJMSB2005114_DISCLOSURES.PDF
27. Emanuel, E. J., Wendler, D., Killen, J., & Grady, C. (2004). What makes clinical research in developing countries ethical? The benchmarks of ethical research. Journal of Infectious Diseases, 189(5), 930–937. https://doi.org/10.1086/381709/3/M_189-5-930-FIG001.GIF

28. Fine, R. L. (2005). From Quinlan to Schiavo: Medical, Ethical, and Legal Issues in Severe Brain Injury. Baylor University Medical Center Proceedings, 18(4), 303–310. https://doi.org/10.1080/08998280.2005.11928086
29. Gallagher, J. (2019). He Jiankui: Baby gene experiment “foolish and dangerous.” https://www.bbc.com/news/health-48496652
30. Greene, J. D. (2009). The Cognitive Neuroscience of Moral Judgment* Joshua D. Greene To appear in. The Cognitive Neurosciences IV.
31. Guide for the Care and Use of Laboratory Animals. (2011). Guide for the Care and Use of Laboratory Animals. https://doi.org/10.17226/12910
32. Human, D., & Fluss, S. S. (2000). “ the World Medical Association ’ S Declaration of Helsinki : Historical and Contemporary Perspectives ”. British Medical Journal, October, 1–24.
33. Igareda González, N. (2020). Legal and ethical issues in cross-border gestational surrogacy. Fertility and Sterility, 113(5), 916–919. https://doi.org/10.1016/j.fertnstert.2020.03.003
34. Ikeke, M. O. (2021). The Role of Climate Ethics in Biodiversity Conservation. 10(3), 205–213. https://doi.org/10.14207/ejsd.2021.v10n3p205
35. Kett, J. C. (2020). Who Is the Next “ Baby Doe ? ” From Trisomy 21 to Trisomy 13 and 18 and Beyond. Pediatrics, 146(August 2020). https://doi.org/https://doi.org/10.1542/peds.2020-0818D
36. Kiani, A. K., Pheby, D., Henehan, G., Brown, R., Sieving, P., Sykora, P., Marks, R., Falsini, B., Capodicasa, N., Miertus, S., Lorusso, L., Dondossola, D., Tartaglia, G. M., Ergoren, M. C., Dundar, M., Michelini, S., Malacarne, D., Bonetti, G., Dautaj, A., … Bertelli, M. (2022). Ethical considerations regarding animal experimentation. Journal of Preventive Medicine and Hygiene, 63(2), E255–E266. https://doi.org/10.15167/2421-4248/jpmh2022.63.2S3.2768
37. Klein, E., & Nam, C. S. (2016). Neuroethics and brain-computer interfaces (BCIs). Brain-Computer Interfaces, 3(3), 123–125. https://doi.org/10.1080/2326263X.2016.1210989
38. Land Use Ethics. (n.d.). Retrieved April 26, 2025, from https://lifestyle.sustainability-directory.com/area/land-use-ethics/
39. Langlois, A. (2008). The UNESCO Universal Declaration on Bioethics and Human Rights: Perspectives from Kenya and South Africa. Health Care Analysis, 16(1), 39–51. https://doi.org/10.1007/S10728-007-0055-7/METRICS
40. Langlois, A. (2011). The Global Governance of Bioethics: Negotiating UNESCO’s Universal Declaration on Bioethics and Human Rights (2005). Global Health Governance : The Scholarly Journal for the New Health Security Paradigm, 5(1), 1. https://pmc.ncbi.nlm.nih.gov/articles/PMC3378037/

41. Lopes, J. A. (2014). Bioethics - a brief history: from the Nuremberg code (1947) to the Belmont report (1979). Revista Médica de Minas Gerais, 24(2), 253–264. https://doi.org/10.5935/2238-3182.20140060
42. Mertes, H., & Pennings, G. (2020). Bioethics in human reproduction (human reproductive genetics). In Human Reproductive Genetics: Emerging Technologies and Clinical Applications. INC. https://doi.org/10.1016/B978-0-12-816561-4.00018-1
43. Milford, A., Clercq, E. De, Louis-maerten, E., & Geneviève, L. D. (2025). How animal ethics committees make decisions – a scoping review of empirical studies. https://doi.org/10.1371/journal.pone.0318570
44. Nagai, H., Nakazawa, E., & Akabayashi, A. (2022). The creation of the Belmont Report and its effect on ethical principles: a historical study. Monash Bioethics Review, 40(2), 157–170. https://doi.org/10.1007/S40592-022-00165-5/TABLES/1
45. Nardini, C. (2014). The ethics of clinical trials. Ecancer, 8(387), 1–9. https://doi.org/10.3332/ecancer.2014.387
46. Nunes, R. (2014). Encyclopedia of Global Bioethics. Encyclopedia of Global Bioethics, December 2014. https://doi.org/10.1007/978-3-319-05544-2
47. Nuremberg - Document Search Results. (n.d.). Retrieved April 9, 2025, from https://nuremberg.law.harvard.edu/search/?q=source:photostat%7Cnmt*
48. Page, S. (2024). Designer Babies : A Phenomenological Study on Genetic Engineering. 18(1), 1–25.
49. Patel, R., Ashcroft, J., Darzi, A., Singh, H., & Leff, D. R. (2020). Neuroenhancement in surgeons : benefits , risks and ethical dilemmas. 946–950. https://doi.org/10.1002/bjs.11601
50. Potter, V. R. (1970). Bioethics, the Science of Survival. Perspectives in Biology and Medicine, 14(1), 127–153. https://doi.org/10.1353/PBM.1970.0015
51. reports from a seminar. (2001). Teaching bioethics. In nord 2002 (Vol. 130). https://doi.org/10.5840/teachphil19814237
52. Resnik, D. B. (2005). The Ethics of Science_an introduction. Taylor & Francis or Routledge.
53. Resnik, David B. (2024). Biosafety , biosecurity , and bioethics. In Monash Bioethics Review (Vol. 42, Issue 1). Springer International Publishing. https://doi.org/10.1007/s40592-024-00204-3
54. Seddon, P. J., & King, M. (2019). Creating proxies of extinct species: The bioethics of de-extinction. Emerging Topics in Life Sciences, 3(6), 731–735. https://doi.org/10.1042/ETLS20190109,

55. Shrestha, B., & Dunn, L. (2020). The Declaration of Helsinki on Medical Research involving Human Subjects: A Review of Seventh Revision. Journal of Nepal Health Research Council, 17(4), 548–552. https://doi.org/10.33314/jnhrc.v17i4.1042
56. Sterodimas, A., & Radwanski, H. N. (2011). Ethical Issues in Plastic and Reconstructive Surgery. 262–267. https://doi.org/10.1007/s00266-011-9674-3
57. Storey, G. P. (2000). Ethical problems surrounding surrogate motherhood. Bioethics, 2, 5.
58. Summers, J., & Morrison, E. (2009). CHAPTER 2 Principles of Healthcare Ethics. In Principles of healthcare ethics. Health care ethics. (2nd ed., pp. 41–58). Sudbury: Jones and Bartlett Publishers.
59. The 3Rs | NC3Rs. (n.d.). Retrieved April 16, 2025, from https://nc3rs.org.uk/who-we-are/3rs
60. The Convention on Biological Diversity. (2025). https://doi.org/10.1016/B978-0-12-809665-9.09972-9
61. Tobin, M. J. (2022). Fiftieth Anniversary of Uncovering the Tuskegee Syphilis Study The Story and Timeless Lessons. American Journal of Respiratory and Critical Care Medicine, 205(10), 1145–1158. https://doi.org/10.1164/RCCM.202201-0136SO/SUPPL_FILE/DISCLOSURES.PDF
62. Universal Declaration on Bioethics and Human Rights | UNESCO. (n.d.). Retrieved April 10, 2025, from https://www.unesco.org/en/ethics-science-technology/bioethics-and-human-rights
63. Vergès, E. (2008). Ethique et déontologie de la recherche scientifique. Qu’en Est-Il Du Droit de La Recherche ? https://doi.org/10.4000/BOOKS.PUTC.2478
64. Williams, J. R. (2008). The Declaration of Helsinki and public health. Bulletin of the World Health Organization, 86(8), 650–652. https://doi.org/10.2471/BLT.08.050955